REPORT OF THE CHIEF OF THE BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE, 1938

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE,
Washington, D. C., September 26, 1938.

Hon. HENRY A. WALLACE,
Secretary of Agriculture.

DEAR MR. SECRETARY: I submit herewith a report of the work of the Bureau of Entomology and Plant Quarantine for the fiscal year ended June 30, 1938.

Sincerely yours,

LEE A. STRONG, *Chief.*

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INTRODUCTION

Among the changes in the organization of the Bureau during the year was the creation of the position of special research assistant to the Chief of Bureau. This position was created so that more attention could be given to unifying the research work of the Bureau, and to make it more effective. P. N. Annand, Chief of the Division of Cereal and Forage Insect Investigations, was appointed to this position, his successor being C. M. Packard, in field charge of the work on the hessian fly, white grubs, and other insects at LaFayette, Ind.

The special educational and demonstrational work on control of the screwworm which was recognized as a separate field division in 1936 was discontinued on February 15, 1938. The extensive work conducted during the last 2 years in cooperation with various State agencies and individuals was believed to have made available to farmers in the areas where screwworms occur adequate information regarding methods of control. The stockmen are believed to have had ample opportunity to became fully advised as to the control of this insect, and the educational and demonstrational work was therefore turned

over to the States and other agencies to be handled in the same general manner as is the work of controlling other important pests.

During the past few years the administration of work in connection with outbreaks of the Mormon cricket and grasshoppers has been under the supervision of the Division of Cereal and Forage Insect Investigations and was directed by persons whose principal interest was research work with respect to these insects. The responsibility for the control work has interfered with the research programs because the control work occurs during the time when emphasis on research work is of greatest importance. In keeping with the organization of the Bureau's work, therefore, it was considered advisable to transfer these control activities to a division dealing exclusively with control work; therefore the control of these insects has been placed in the Division of Domestic Plant Quarantines. W. E. Dove, who was in charge of the educational and demonstrational work on screwworm control, was placed in field charge of the grasshopper-control program and established his headquarters in Minneapolis, Minn. Claude Wakeland was appointed to take field charge of the Mormon cricket work and his headquarters were established at Salt Lake City.

The death of Leon H. Worthley, for many years one of the leaders in the various pest-control activities of the Bureau, left a vacancy in connection with the Division which has the activities of controlling the Japanese beetle, eradication of the Dutch elm disease, enforcement of the gypsy moth quarantine, and European corn borer certification. This vacancy was filled by the promotion of Erle G. Brewer, assistant to Mr. Worthley, whose promotion became effective October 16, 1937.

The eradication and control of plant pests was continued under a program expanded by means of allocations of emergency relief funds. A curtailment in the general relief program resulted in reduced allotments with a corresponding reduction in the volume of work carried on under these funds. This reduction was likewise reflected in the cooperation in plant-pest control received from camps operated by the Civilian Conservation Corps.

PUBLICATIONS AND EDITORIAL WORK

During the year 520 manuscripts were presented for publication and 461 were approved, 93 being submitted to the Department for publication and the remaining 368 to outside journals. There remained on hand at the end of the year 185 manuscripts, 138 of which were under consideration in the Bureau, 40 were in the Office of Information awaiting publication by the Department, and the remaining 7 were in press at the Government Printing Office. Of the 138 in the Bureau, 82 were being considered for publication by the Department and the remaining 56 for publication in outside periodicals.

LIBRARY

The loan and reference work with books and periodicals for the Bureau staff increased over 22 percent this year.

Special bibliographies prepared to aid investigators include those on effect of radium on insects, longevity in insects, reproduction in insects, biology of *Carpocapsa pomonella*, plant-quarantine history, aims, and problems, and a brief list on toxicology. Entomology Current Literature appeared regularly bimonthly, with 156 pages as compared with 135 pages last year. The outstanding bibliographic work for the year is the Index to American Economic Entomology V, a volume of 693 pages containing some 35,000 references, compiled in the Bureau library and published by the American Association of Economic Entomologists in April 1938.

The special collection of photographs of entomologists was completely cataloged and much biographic and bibliographic information was assembled.

INSECT PEST SURVEY AND INFORMATION

The Survey added to the permanent files on the distribution and abundance of insects 14,000 notes on domestic insects and 5,000 notes on foreign insects, bringing the total now available for consultation to 278,650 notes. The work of the year added 925 species of insects to the existing record of approximately 20,000 species of American insect pests and the foreign pest file now contains over 21,000 species of insects.

The important development of the year was the increase in personnel of the Survey to a force of six professional and subprofessional workers. This group is concentrating its efforts on bringing up to date the records on insects of the world not known to be in this country, in order that there may be available in the Bureau concise information on any pest of the world that may appear in this country or may be intercepted in commerce.

The monthly Insect Pest Survey Bulletin was augmented by supplements on Alfalfa Weevil Survey, Fall of 1936; The Two Broods of Periodical Cicada Scheduled to Appear in 1937; the Species and Distribution of Grasshoppers in the 1936 Outbreak; Spread of Alfalfa Weevil in 1937; Hessian Fly Survey, Harvest-Time 1937; Liberations of Parasites of the European Corn Borer in the United States in 1937; Liberations of Japanese Beetle Parasites in the Eastern States in 1937; and Insect Notes from Costa Rica in 1936.

The value of the Survey work to the separate States is evidenced by an International News Service release, dated July 10, wherein the extension entomologist of Alabama warned through the press in his State that the cotton leaf worm was likely to appear in Alabama and other Southeastern States in the immediate future, stating that he based these conclusions on Survey reports that the insects were found in southern Texas on May 27 and in Calhoun County, Tex., on June 9.

Ninety-four articles on entomological and quarantine subjects were released to the press and 72 radio talks were put on the air. Preparation of film-strip material covered six new subjects. No new motion pictures were completed, but three important motion pictures are being made, one on grasshoppers, one on the Mormon cricket, and one on the white-fringed beetle. The Bureau participated in seven exhibits.

Cooperative extension work in entomology was supervised under the direction of the Bureau and the Office of Cooperative Extension Work.

Twelve numbers of the Bureau Monthly News Letter were issued, comprising a total of 363 pages. Publications to the number of 331,775 copies were distributed, exclusive of those sent out on regular mailing lists and miscellaneous mimeographed material.

During the year the photographic unit of the Bureau prepared 539 negatives illustrating the genitalia of May beetles of the genus *Phyllophaga*, a special project under the general direction of Philip Luginbill. For this particular work 4,850 prints were made in addition to 12,575 prints prepared for the general activities of the Bureau.

To the file of photographic prints under the custody of this division 492 new subjects were added, and 463 prints were distributed in answer to special requests from scientific workers, magazine editors, writers, students, teachers, and others.

FRUIT INSECT INVESTIGATIONS

APPLE AND PEAR INSECTS

The most striking feature of the work of the 1937 season was the very favorable results obtained in the Middle West by the use of nicotine-bentonite for the control of the codling moth. The tank-mix nicotine-bentonite developed by the Vincennes, Ind., laboratory, mentioned in last year's report, was found especially effective. A practical test of this material gave opportunity to secure data on its behavior on a schedule substantially the same as that followed with lead arsenate. It appeared equal to or better than lead arsenate in preventing worm entrance, was much better in controlling the sting type of blemish, and gave much less difficulty in residue removal. The increase in cost of the material appeared to be more than offset by the improvement in codling moth control and in the condition of the trees. A number of problems remain to be investigated further in connection with the fixed-nicotine materials. A particularly urgent need is the development of fungicides that will not interfere with the effectiveness of the nicotine combinations and yet will be safe for use on the trees.

Phenothiazine gave poorer results in the Northwest than previously, in part because it was tested at lesser strengths, and apparently in part because of an unusual rainfall of more than 2 inches that occurred in June, resulting in conditions more comparable to those existing in the Middle West and East, where the results with phenothiazine have been very disappointing.

Practical field experiments with orchard sanitation and banding gave reductions in infestation ranging from 20 to 60 percent, demonstrating conclu-

sively the value of these practices, especially under conditions of severe infestation.

Studies of methods of carrying on bait-trap experiments, conducted in southern Indiana, indicated that a great deal of the extreme tree-to-tree variation in moth captures can be smoothed out by rotating the test baits among the trees. The use of bait traps in a block of 276 trees appeared to reduce the first-brood infestation approximately 50 percent. The season's infestation, however, was reduced only about 25 percent, which indicates that the movement of moths during the summer equalized many of the differences that existed earlier in the season. In the Pacific Northwest reductions of approximately 50 percent were obtained in large-scale experiments with bait traps.

A cooperative project dealing with the control of the codling moth by mechanical methods and by the stimulation of biological control without spraying was continued in West Virginia through the season of 1937. The crop was comparatively light and the percentage of infested fruit increased from 55 percent in 1936 to 71.8 in 1937. This Bureau continued to cooperate with the Idaho Agricultural Experiment Station in the biological project at Parma, Idaho. During the season 1,085 adults of *Acnoplex carpocapsae* Cush. and 2,169 adults of *Ichneumon extensor* (Tasch.) were sent to Parma for use in this experiment.

Further experiments were carried on in cooperation with the Oregon Agricultural Experiment Station to determine the part played by the pear thrips in causing injury of the russet or scab type on prunes. Careful cage tests and experiments involving the use of windbreaks to exclude wind injury demonstrated definitely that the thrips is responsible for a typical scab on the fruit. The most important loss caused by thrips on prunes, however, consists in the prevention of the fruit from setting, and the dropping of the set fruit caused by egg laying and feeding of the thrips, which causes a partial or even complete crop failure.

PEACH INSECTS

Work with the parasites of the oriental fruit moth was continued. During 1937, eight shipments from Japan and two from Australia were received, from which were reared 38,545 adult parasites. During the season 187 releases involving a total of 39,908 parasites were made in 11 States, mostly in the Middle West, which has previously not received as many colonies as the Eastern States. The mortality of the parasites in transit averaged only 1 percent of the season's shipments to the field. Four hundred and twenty-seven recovery collections were obtained from 19 States, three-fourths of them having been furnished by cooperating agencies. In general parasitization showed a decided increase for 1937 as compared with 1936.

Experiments with the production of *Macrocentrus ancylivorus* Roh. on the strawberry leaf roller under large field cages indicated that this method of production is practical. Field studies were made to determine the capacity of various parasites for increase and spread during the season in which they are released in orchards.

Recovery collections again indicate that *Macrocentrus ancylivorus* was the most abundant and widely distributed parasite species in most of the areas. *Glypta rufiscutellaris* Cress. ranked second from the standpoint of distribution, and third in abundance; *Dioctes molestae* Uchida was in third and second places respectively. Other species showing wide distribution and reared in considerable numbers were *M. delicatus* Cress., *M. instabilis* Mues., and *Pristomerus occllatus* Cush.

Investigations dealing with the use of ethylene dichloride emulsion and other materials for peach borer control were broadened in the fall of 1937 and spring of 1938 to include informal cooperative experiments in southern Illinois and western New York in comparison with similar experiments in Georgia. In all these experiments the results with ethylene dichloride were outstanding, both as to borer control and safety for use on trees. A further advantage lies in the fact that ethylene dichloride is effective at much lower soil temperatures than is paradichlorobenzene in crystal form or as an emulsion in cottonseed oil. This greatly increases the length of the season for fall treatments in the Northern States.

Barium fluosilicate and cryolite were tested in parts of the spray program and gave plum curculio control not significantly different from that obtained by the use of the standard lead arsenate schedule. Unfortunately both these fluorine compounds caused serious injury to the fruit. Curculio control resulting from the use of a full schedule of derris powder was considerably inferior to that obtained from the use of lead arsenate.

The survey method of approach to the study of the possible relation of insects to the transmission of the phony peach disease and the peach mosaic disease was continued. Two trailer laboratories are in operation and are covering the territory in which these two diseases occur. Each trailer laboratory traveled more than 10,000 miles during the season of 1937. In connection with the survey work, a fixed laboratory was established at Brownwood, Tex., in cooperation with the Bureau of Plant Industry, for work in the incrimination, in the transmission of the peach mosaic disease, of certain insects which were determined as suspects in the survey work.

GRAPE INSECTS

Phenothiazine was given further testing against the grape berry moth, and was again found to have outstanding insecticidal properties for this purpose. When used alone it was found to have very poor wetting properties; with a small quantity of sodium lauryl sulphate it was wet much more readily but the deposit was removed to some extent by rains. Nicotine-bentonite and nicotine-oil in the second brood, following calcium arsenate in the first, gave effective control of the berry moth, but caused a somewhat objectionable staining of the fruit.

Cooperative tests with growers continued to show that an important reduction in the spring brood of the berry moth may be obtained by a method of spring cultivation of vineyards which keeps the cocoons buried until after the normal time of emergence of the adult moths. This method appears to be most successful in the lighter soil types.

Further coöperative experiments with blast-burning equipment, designed by the Bureau of Agricultural Engineering, to test the possibility of controlling leafhoppers in hibernation areas close to vineyards again resulted in greatly decreased numbers of the adult hoppers in the vineyards in the spring.

NUT INSECTS

Attention was given at Albany, Ga., to the biology of the hickory shuckworm to obtain a better basis for further investigations on the control of the insect as a pest of pecan. During 1937 the hickory shuckworm passed through three generations and a partial fourth. The pupation of larvae from the overwintering generation extended through the entire season of 1937, the last moth emerging on December 28. About 20 percent of the individuals that hibernated as larvae in the winter of 1936–37 did not transform during 1937.

Preliminary investigations were conducted at Albany to determine whether *Macrocentrus ancylivorus* and *Ascogaster quadridentatus* Wesm., both of them important parasites of the oriental fruit moth and the latter of special importance as a codling moth parasite, would attack the closely related hickory shuckworm. Efforts to cause *M. ancylivorus* to attack the mature shuckworm larvae were unsuccessful. The results with *A. quadridentatus* were also negative. A considerable number of parasites of the shuckworm and other pecan insects were reared, adding to the accumulation of information on this subject.

Studies carried on in central Texas resulted in the development of a simple method of timing the spray applications for the nut casebearer, thus permitting control with one application where previously two were desirable. The results of the experiments in central Texas with both lead arsenate and nicotine sulphate with oil confirmed those of previous years' experiments.

At the new cooperative laboratory at Monticello, Fla., nicotine sprays of various kinds gave considerable control of the nut casebearer, the greatest reduction resulting from the use of nicotine-bentonite with summer oil in two applications. In Florida dormant applications of tar-oil emulsions resulted in the killing of 96 percent of the hibernating larvae. This material, however, caused moderate injury to the foliage on the early developing varieties, the buds of which had begun to swell at the time the spraying was done.

Results of experiments with the use of oil sprays for the control of the obscure scale confirmed results secured in previous years, indicating that dormant applications of oil emulsions at strengths of 2, 3, or 4 percent give satisfactory control. The delayed effect of oil sprays on the obscure scale, reported a year ago, was evident again in 1937. The laboratory at Shreveport, La., where this work has been carried on, was closed and the personnel and equipment transferred to Brownwood, Tex.

A new laboratory was opened at Eugene, Oreg., in August 1937 for a study of certain insect problems that are affecting the development of the filbert industry in the Pacific Northwest. A study of the filberts being delivered to the drying houses revealed the fact that worm infestation, presumably by the Catalina cherry moth (*Melissopus latiferreanus* (Wlsm.)), exists in a large number of widely distributed filbert orchards located from western Washington through western Oregon practically to the California line.

DRIED-FRUIT INSECTS

As last year, the Fresno, Calif., laboratory cooperated informally with the Marketing Division of the Agricultural Adjustment Administration, the Extension Service of the University of California, and the Dried Fruit Association of California in a large-scale demonstration of the effectiveness of shade-cloth protection of drying peaches. This involved the use of 20,000 linear yards of cotton cloth, which was used by 82 growers in 14 different counties. The use of the cloth under commercial drying-yard conditions resulted in a reduction in infestation from an average of about 45 to approximately 9 percent.

Preliminary experiments were carried on with the use of low temperatures for the control of various insects infesting dried fruits. Consideration must also be given to the effect of the cold-temperature treatments on the product.

SUBTROPICAL FRUIT INSECTS

The work to determine the effect of tartar emetic on citrus trees, in cooperation with the Bureau of Plant Industry, was completed. During two seasons with more than the usual rainfall, and one with less than normal, no effect on the foliage, fruit, or trees was observed, and no significant changes in the populations of scale insects and whiteflies were noted in the course of the experiments.

Definite progress was made toward a standardized laboratory procedure for handling the so-called resistant California red scale before, during, and after fumigation experiments, mentioned in the last report. Marking the individual scales treated helped greatly in the work. The condition and type of the host lemons and the density of the scale population seem to be the important factors as yet uncontrolled. Population counts indicated that a winter season with temperatures low enough to necessitate orchard heating will not reduce the scale population enough to permit the omission of even one fumigation.

The investigations of thrips control on oranges was completed. Cooperative experiments carried on near Phoenix, Ariz., indicated that a three-application sulphur-dusting program, properly timed, will give satisfactory control of the citrus thrips on oranges in that area. In lemon groves in the coastal area of California, where the thrips population was very high, the usual sulphur-dusting programs for oranges gave control early in the season, but by late in the summer the thrips population had built up to a high enough point to permit serious damage. Materials other than sulphur were also tested. Observations made in an orange grove at Redlands, Calif., showed that the plot dusted with sulphur for 2 years is for all practical purposes free of black scale, whereas the undusted area in the same grove is not commercially clean.

Preliminary work was done in California looking toward the development of the use of added toxicants with oils for the control of the California red scale. Butyl phthallate was found to be a satisfactory solvent for petroleum oils and certain organic toxicants. Preliminary tests were carried on with various petroleum and vegetable oils in combination with nicotine and with rotenone.

In Florida heavy infestations of scale insects developed on trees and fruits where materials containing hydrated lime and other substances leaving heavy residues were applied. The trees receiving the larger quantities of adhesive materials developed higher scale populations.

JAPANESE AND ASIATIC BEETLES

The area of continuous infestation occupied by the Japanese beetle increased approximately 2,500 square miles over the area of 2 years previous. In the older infested areas, however, the beetles were less abundant and caused less injury than in 1936. Severe injury occurred over an area that included northeastern Maryland and northern Delaware, eastern Pennsylvania, north-central New Jersey, and the New York City metropolitan area.

The influence of particle fineness on the effectiveness of lead arsenate in controlling the Japanese beetle was studied under laboratory conditions. With

the adult beetles, the more finely divided materials appeared slightly more effective but the difference was not great. For control of the larvae or grubs in the soil, more finely divided lead arsenates were somewhat more effective than coarser materials. The addition of gum arabic or lauryl sulphate to the sprays improved their immediate effectiveness and facilitated the washing of the residues from the grass into the soil.

Preliminary results with ground derris indicated that the more finely divided materials may prove more effective than the coarser ones as repellents for the adult Japanese beetle. Results with various materials intended to inhibit decomposition of the active ingredients of derris by sunlight failed to reveal any satisfactory material for this purpose. The work on the decomposition of rotenone, as measured by chemical means, indicated that some constituent of derris other than rotenone may be an important factor in its repellent effect.

Work with parasites of the Japanese beetle was continued as in previous years. During the spring of 1938, 315 colonies of *Tiphia vernalis* Roh. were liberated. Most of these were placed in Maryland as an aid in the Japanese beetle-retardation campaign which is being carried on by the Maryland State authorities. Of 352 colonies of this parasite liberated during the period 1926 to 1934, inclusive, recoveries have now been made at 224 locations. One colony which was studied in detail showed that the average parasitization of the Japanese beetle grubs has been 36 percent. A type strain of *T. popilliavora* Roh. established at 50 percent of the points at which releases were made from 1921 to 1934 does not appear to be increasing rapidly, presumably because of the incomplete synchronization of the egg-laying period of the adult parasite with the third-stage Japanese beetle grubs necessary for its normal development. A Korean strain of this species appears later in the season and is expected to become more effective. Nine colonies of the Korean form were released in Delaware, Maryland, New Jersey, and Pennsylvania. The numbers of a Yokohama strain of the same species, which is likewise better synchronized with its host, are being increased in the insectary in preparation for liberation next year.

Work with the various disease organisms that attack the Japanese beetle in the grub stage was continued. Studies of the so-called milky diseases indicated that field plots may be successfully infected by a number of different methods. A marked reduction in beetle emergence was apparent in all the plots treated with the milky disease organisms, regardless of the method of application. Positive evidence was obtained that the parasite *Tiphia vernalis* plays a part in the dissemination of the milky disease, and indications were obtained that adult Japanese beetles may disseminate the disease organisms. Experiments indicated that the infective spores in diseased larvae consumed by chickens passed through the digestive tract of the chickens without loss of vitality, adding further evidence to the supposition that birds may play a part in the distribution of the milky disease. Spores of both A and B types of the milky disease remained viable for 25 months in soil stored under a number of different conditions from which Japanese beetle larvae were excluded. In the plot started in 1935 at West Chester, Pa., diseased larvae also were recovered in scattered diggings made several miles from the original plots.

In cooperation with the Division of Cereal and Forage Insect Investigations of this Bureau and with the Bureau of Plant Industry, detailed studies were made of the susceptibility of 51 varieties of sweet corn and field corn to attack by the Japanese beetle. Seed was furnished by the agricultural experiment stations of Connecticut, Illinois, Indiana, and Iowa. Although significant differences in sterility, resulting from the feeding of the beetles on the silk, were found among the various strains, no associations between these differences and the beetle populations appeared evident. Two varieties of soybeans in the same area were both attacked vigorously, approximately 60 to 70 percent of the foliage which appeared during the beetle-feeding season being severely injured or destroyed.

FRUITFLY INVESTIGATIONS

Studies in Hawaii with the melon fly showed that an exposure of 15 days at 35° F. results in complete mortality even where high larval populations are involved. This indicates a slightly greater resistance to low temperatures than with the Mediterranean fruitfly, corresponding mortalities for that species apparently being obtained at 36°.

Data accumulated in Mexico with the vapor-heat process have made it possible to reduce the exposure time to 6 hours when the approach period

is not reduced below 8 hours, a suitable approach for commercial loads. In Mexico, also, an analytical method for tartar emetic was perfected which permits a determination of the amount and distribution of tartar emetic on leaves and fruit after spraying. This method does not require a laboratory and can be used by anyone in the field.

Protein lures first developed with fruitflies in Mexico have now proved the most efficient not only for the Mediterranean fruitfly but for fruitflies in Puerto Rico. In that island they are shown to be especially good when fruitfly populations are low, indicating that they are suitable for inspection purposes.

MEXICAN FRUITFLY CONTROL

The harvesting season of 1937–38 witnessed the highest production of citrus fruit in the Rio Grande Valley of Texas since the industry was established. The crop totalled 34,927.4 equivalent carloads. Although the harvesting season had been extended from March 31 to April 30, the packing, marketing, and processing facilities were used to capacity throughout the year so that the crop might be moved within the time limits prescribed under Quarantine No. 64.

INFESTATIONS

In the spring of 1937 a heavier infestation of the Mexican fruitfly than usual developed in the area covered by Quarantine No. 64. It was expected that if the flies that emerged as a result of this infestation remained within the area there would be a similar condition in the spring of 1938. By midsummer of 1937, however, the traps disclosed that the fly population was no higher than usual. Traps operated throughout the year indicated that the fly movement was normal during the entire season. Few flies were trapped before January, and at no time after the first of the year was the population as high as in the preceding season.

Larval infestations were found on 218 premises. These infestations occurred during the months of February through the early part of May, the peak being reached late in March. This is the second highest number of infestations for one season on record, but for comparison purposes it should be remembered that the harvesting period was extended 30 days over last year and as much as 60 days over some former years.

Table 1 shows the number of flies trapped, the number of larval infestations, and the date of close of the harvesting season for the fiscal years 1934–38.

TABLE 1.—*Infestations of the Mexican fruitfly in Texas*

Fiscal year	Flies trapped	Larval infestations	Harvesting season closed	Fiscal year	Flies trapped	Larval infestations	Harvesting season closed
	Number	*Number*			*Number*	*Number*	
1934	276	5	Apr. 5.	1937	4,714	1,062	Mar. 31.
1935	367	30	Apr. 2.	1938	[1] 712	218	Apr. 30.
1936	251	5	Mar. 31.				

[1] 79 outside of area.

STERILIZATION

Sterilization of fruit from infested groves was required throughout the season. Both high- and low-temperature methods were used. The high-temperature method proved more popular, as the time required for sterilization is only 6 hours at 110° F. at the center of the fruit. The total time necessary for sterilization, however, is approximately 20 hours. This includes the time required to bring the fruit up to 110°, the sterilization period, and the cooling period.

Sterilization at low temperatures was employed in a limited number of cases, but as it requires holding the fruit for 15 days at a temperature of 30° to 31° F., a much greater volume of fruit must be accommodated for an equal output.

Intensive inspection plus sterilization of the fruit whenever infestations are found reduces to a minimum the possibility of any infested fruit's leaving the quarantined area.

CANNING PLANTS

The citrus-canning industry continued the rapid growth noted last year. Of the total amount of grapefruit produced and harvested for shipment 45.6 percent was canned. By far the greater portion of this fruit was used for juicing purposes. This increase in the amount of grapefruit canned was brought about primarily because the fresh fruit markets could not absorb the crop as it was harvested.

No oranges were processed in the Rio Grande Valley during the season of 1937–38.

SHIPMENT OF FRUIT

Railroads, trucks, and steamers shared in the movement of citrus from Rio Grande Valley. Although production increased in excess of 4,000 equivalent carloads this season, approximately 3,350 equivalent carloads less were shipped as fresh fruit. This loss in shipments is accounted for by the reduction in production of oranges and by the increase in the amount of grapefruit processed.

Table 2 shows, in equivalent carlots, the shipments of fruit either certified for movement from this area or moved under supervision of inspectors, the amount canned, and the commercial production for the fiscal years 1933–38.

TABLE 2.—*Citrus fruit from Rio Grande Valley, Tex., shipped and canned, and total production, in equivalent carlots, fiscal years 1933–38*

Fiscal year	By rail		By truck		By boat		By express and passenger car, mixed	Canned grapefruit	Commercial production
	Grapefruit	Oranges	Grapefruit	Oranges	Grapefruit	Oranges			
	Carlots	*Carlots*	*Carlots*	*Carlots*	*Carlots*	*Carlots*	*Carlots*	*Carlots*	*Carlots*
1933	2,897	230	880	586	----------	----------	101	127	4,821
1934	1,748	114	1,236	877	----------	----------	99	240	4,314
1935	4,617	225	1,731	1,095	----------	----------	239	1,131	9,038
1936	4,262	600	1,454	1,182	----------	----------	267	1,682	9,447
1937	15,616	2,729	2,578	2,351	176	17	[1] 532	[1] 6,702	30,701
1938	13,736.3	1,322.7	2,817.4	1,991.5	183.1	4.7	596.1	14,278.6	34,927.4

[1] Includes 2 cars of oranges processed.

REVISION OF QUARANTINE NO. 64

Quarantine No. 64 was revised, effective October 15, 1937, to include a portion of Jim Wells County, Tex., in the regulated area, and to fix the host-free period from May 1 to August 31 of each year.

JAPANESE BEETLE QUARANTINE AND CONTROL

TRAP SCOUTING IN NONREGULATED TERRITORY

Developments of the trap scouting of 1937 disclosed a reduction in the previously reported infestations at St. Louis and Chicago, and a scarcity of first-record infestations of an established nature.

Trap scouting for the Japanese beetle was carried on during the summer of 1937 in 415 cities and towns in 25 States, scattered from Florida to Vermont, and westward as far as Denver. There were also included a few traps operated by California authorities in Sacramento and Roseville. Approximately 111,000 traps were set, an increase of 7,500 over the previous year. Some trapping activities were conducted in all but 16 States outside the present quarantined area. The average operation period for the traps was 1 month.

Results of trapping in the nonregulated area in 1937 disclosed 31 first-record infestations, as compared with 36 the previous year. Of these, 3 were in Illinois, 3 in West Virginia, 4 in Virginia, 10 in Maryland, 7 in Ohio, and 1 each in Georgia, Indiana, Pennsylvania, and New York. Beetles were caught in 62 communities in which incipient infestations had been determined. Trapping in 322 cities and towns gave negative results.

In North Carolina beetles in varying numbers were caught in all but 2 of the 15 known infested communities in which traps were used. Beetles in considerable numbers were collected in Greensboro, Spencer, East Spencer, and Winston-Salem. There was little change in the conditions of infestation in these cities as compared with 1936.

In the South Central States trap surveys were made in Kentucky, Tennessee, Alabama, and Louisiana. In Kentucky trapping was repeated this year, 391 traps being used in Lexington and 800 in Louisville, with positive results. This year 151 traps were operated in Bristol, Tenn., with negative results, showing that the insect did not persist in the section where 4 beetles were caught in 1936. Four hundred traps were set in Chattanooga, Tenn., 398 in Knoxville, Tenn., 400 in Nashville, Tenn., 400 in Mobile, Ala., and 1,125 in New Orleans, La., all with negative results.

Traps were set in all North Central States except the Dakotas and Minnesota. The number of cities and towns surveyed in the unquarantined States were: Indiana 12, with 8,200 traps; Michigan 9, with 7,727 traps; Illinois 13, with 15,167 traps; Wisconsin 3, with 2,390 traps; Missouri 14, with 16,743 traps; and 1 each in Iowa with 400 traps, Nebraska with 398 traps, and Kansas with 780 traps. All trapping in Wisconsin, Iowa, Nebraska, and Kansas gave negative results.

There was a still further reduction in the Indianapolis infestation. Three thousand five hundred traps were used and only 12 beetles were caught during the season, whereas previous annual catches since 1934 had been 17, 57, and 28. Seven of this year's collections were caught in areas treated with lead arsenate in April 1937 and the remainder were trapped at scattered points outside. Positive results were obtained at Fort Wayne, South Bend, and Logansport, Ind., this season, 800 traps each having been used at Fort Wayne and South Bend and 300 in Logansport. Trapping was conducted in eight Indiana communities with negative results.

As a result of applications of lead arsenate to the Detroit, Mich., infestation prior to the summer of 1937, collections there were reduced from 128 to 67, with 5,045 traps in operation. In Dearborn 6 beetles were caught in 796 traps. No other infestations were determined in the State.

Control work in Chicago resulted in speedy reduction of beetles in the lead arsenate-treated area. From a city-wide total of 3,740 beetles in 1936 the combination trapping and treating program made such inroads on the beetle population that only 384 were taken this year. Approximately 10,000 traps were set out this year in Chicago, 3,000 of which were State-owned. When the heavy infestation was discovered last year near Bessemer Park in southeastern Chicago, 3,637 beetles were trapped in 72 contiguous blocks, 1 lone block accounting for 1,101 of these; 37 beetles were collected in 30 scattered blocks in the same area. Excellent control was obtained in sections treated in the fall of 1936. In the most heavily infested block in the city, trap captures were reduced from 1,101 to 2 beetles, and there was a 93.4 percent reduction from 3,674 to 242 throughout the Bessemer Park section. Intensive hand scouting was also performed in the immediate vicinity of trap finds. In the next largest infested area the reduction was from 55 to 35 beetles. Only 14 of these were found in treated blocks, the remainder having been caught outside the infested section as determined by trapping in 1936. An infestation of 23 beetles several miles south of Bessemer Park and 2 others of 29 and 38 beetles in the northern part of the city were the most important infestations found outside sections previously known to contain the beetle. Small collections of a few beetles each were made in five scattered sections in the south-central portion of the city.

Traps were likewise operated in the suburban areas of Chicago and first-record collections at Cicero and Evanston resulted. Three hundred and eighty-eight traps in Elgin, Ill., resulted in the capture of a solitary beetle for a first record. The only other collection in the State was made at East St. Louis, where 1,234 traps collected 3 beetles. A few beetles have been trapped there each year since 1934.

Freedom from infestation of 13 Missouri cities was indicated; one beetle in St. Louis was the only capture in the entire State this season, although 14,757 traps were used in St. Louis and its suburbs. In Denver and Pueblo, Colo., 398 traps, and 400 traps in Sacramento and Roseville, Calif., also failed to take beetles.

Trapping was performed in 18 West Virginia communities, 3,195 traps being set; in 9 locations results were negative. First-record trap collections were made in Harpers Ferry and at Philippi. A heavy first-record infestation covering considerable territory was observed at Hedgesville by the assistant

State entomologist, who supervised the trapping activities throughout the State. Collections indicated that beetles have persisted in negligible numbers in Charleston, Charlestown, Huntington, Martinsburg, and Princeton. At Wheeling traps showed a persistence of the beetle in slightly greater numbers.

Rather extensive trapping was done in Virginia, involving 84 communities and 5,073 traps. Catches were made in 13 cities and towns. Other than a sizeable, established, new infestation at Wakefield, the only first records uncovered were limited to small collections at three points. At the George Washington Birthplace National Monument at Wakefield a heavy but apparently localized infestation was brought to the Bureau's attention by the National Park Service. In previously discovered Virginia infestations, catches were made in Charlottesville, Pulaski, and Roanoke. Persisting small infestations were found in six other localities in the State.

Trapping in Maryland extended to 90 cities and towns, and 1,197 traps were placed. Seventy-three localities were trapped with negative results. First-record infestations were found at 10 localities. Carry-over infestations, most of them of several years' standing, were determined at seven other places. Three small infestations were discovered by nursery and greenhouse scouts in sections just outside the regulated area in Carroll and Talbot Counties.

First-record trap finds in Ohio comprise 7 locations, and isolated infestations discovered in previous years and found to have persisted include 6 locations in the eastern half of the State. In all, 15,738 traps were set out in Ohio. At Marietta, where delayed treatments of lead arsenate were applied in the spring of 1937, collections declined from 121 to 45. Of these 38 were found in the treated area and 7 in adjacent or neighboring blocks. Additional trapping in 38 other Ohio communities gave negative results.

Although nonregulated territory in New York was rather extensively surveyed with 7,154 traps, only 1 new point of collection was found, while traps were operated in 25 cities with negative results. In Rochester, Watkins Glen, Hornell, Niagara Falls, Oswego, and Watertown the infestations of previous years have persisted. In the northwestern corner of Pennsylvania outside the regulated area 4,189 traps were used in 14 towns. The collections showed that 10 towns had no infestation, while beetles were caught in 4 towns, 1 of which was a first record.

No beetles were caught in Vermont, although 400 traps were set in 25 communities throughout the nonregulated section of the State.

Arrangements were made for the operation during the summer of 1938 of a dozen traps in the vicinity of each of the 125 field stations of the Bureau throughout the United States.

Early-season trapping activities during 1938 began with the placement of traps in Fabens, Tex., on April 12. Trapping was completed before the end of the year in Mobile, Ala., Douglas and Safford, Ariz., Valdosta, Ga., Tallulah, La., Leland, Miss., and Las Cruces, N. Mex., and the five localities in Texas. At the end of the year traps were in operation in 225 cities and towns in 20 States.

Trap captures recorded during May and June 1938 included 95 beetles at Atlanta, Ga.; 18 at Louisville, Ky.; 10 at Durham, 1 at Kingston, 17 at Raleigh, 13 at Sanford, 1 at Thomasville, 38 at Wilmington, 2 at Elizabeth City, 6 at High Point, and 4 at Wilson, N. C.; 1 at Marietta, Ohio; 2 at Charleston and 5 at Greenville, S. C.; and 142 at the George Washington Birthplace National Monument at Wakefield, Va. The finds at Kingston and Thomasville, N. C., were first records; the others were survivals of previously determined infestations.

SUPPRESSIVE MEASURES

Based on the results obtained by trap scouting during the season, suppressive measures were carried out in Georgia, Illinois, Indiana, Kentucky, Michigan, Missouri, New York, Ohio, Pennsylvania, and Virginia.

Field treatments in Chicago were resumed in the fall of 1937, and 58.5 acres outside the previously treated areas received lead arsenate applications. A substantial emergency State appropriation was furnished for this work. Treatment was again begun in the spring of 1938 and continued into the next fiscal year. In addition to the soil treatment in Chicago, 19.2 acres were covered in Evanston between October 6 and 22, 1937.

In St. Louis, Mo., 2.7 acres were treated, covering the yard and surrounding premises where the one beetle was found.

In Detroit, Mich., soil treatments were made during October covering 39.7 acres of newly infested area in the city. Late in October 10.9 acres were treated in the area where beetles had been discovered in nearby Dearborn.

Infestations covering 40 acres were treated with lead arsenate in Fort Wayne, Ind., between October 12 and 27, 1937. Treatments were applied on November 1, 1937, to 0.6 acre to cover the limited area found infested outside the previously treated sections in Indianapolis. At South Bend, Ind., the treating program began April 12 and covered the 37.1 acres by April 27, 1938.

Treatment of 17.8 acres in Atlanta, Ga., was made between April 5 and 26, 1938.

In Virginia approximately 13 acres were treated at Wakefield between September 8 and 15, 1937. At Charlottesville 4 acres were treated between April 30 and May 5, 1938.

At Erie, Pa., treatment was started April 25 and completed May 23, 1938, with approximately 36 acres treated.

A soil-treating program in Rochester, N. Y., was begun April 18 and completed May 26, covering approximately 75 acres.

At Louisville, Ky., 5 acres were sprayed late in May 1938.

In Ohio 5 acres were treated at Marietta between May 16 and 21, 1938, and 7 acres at Ashtabula between May 26 and June 3, 1938.

All the soil-treating projects were sponsored by State, city, or other agencies, with the Federal Government furnishing treating equipment and men for its operation and supervision.

FEDERAL AND STATE REGULATORY MEASURES

Revised regulations were issued, effective April 11, 1938, to extend the restricted zone in Ohio, New York, West Virginia, Pennsylvania, Maryland, and Virginia. This revision added Wheeling, W. Va., and Coshocton, Ohio, to those cities which further require the certification of fruits and vegetables shipped during the period June 15 to October 15, inclusive, from other portions of the regulated zone. No restrictions, however, were placed on the movement of any fruits or vegetables from these isolated portions of the regulated area. The amendment also added Lancaster County, Pa., to the territory from which the movement of fruits and vegetables by refrigerator car or motortruck is restricted.

A supplementary revision of instructions to inspectors on the treatment of nursery products, effective December 20, 1937, authorized the fumigation of strawberry plants for Japanese beetle larvae.

A revision of the list of articles exempt from certification requirements, effective March 18, 1938, extended the list. Instructions were also issued, effective May 2, 1938, authorizing the fumigation of potatoes with methyl bromide.

Intrastate quarantines were issued by Indiana, Illinois, Pennsylvania, and West Virginia. West Virginia extended its regulated area. The other States placed under regulation the untreated, established infestations within their borders.

Incipient infestations in Georgia, Kentucky, Michigan, Missouri, and South Carolina were not of sufficient importance to justify quarantine action. The situation in North Carolina was adequately handled by continued enforcement of an intrastate quarantine extending to all important isolated infestations in the State. A North Carolina inspector devoted his time to enforcing the State regulations. Chemical treatment of isolated infestations was employed in Illinois, Michigan, Georgia, Indiana, and Kentucky.

HIGHWAY INSPECTION SERVICE

During July 1937, with road movements of quarantined products at a peak, three stations were added to those already in operation on the boundaries of the regulated area. Thirty-five roads were posted by August 1. Of these, 1 was in Maryland, 6 in Ohio, 11 in Pennsylvania, 11 in Virginia, and 6 in West Virginia. At the peak of the work 65 road inspectors were employed.

Closing of the regular stations began early in October, and rapid abandonment of the posts continued during November, with seven stations remaining open. By December all stations had been closed.

Organization of the road-patrol activities in the spring of 1938 began with the posting, during the last week in March, of five road stations to inspect southbound traffic from the Virginia regulated zone. During April, 17 additional posts were established in West Virginia, Ohio, and Pennsylvania, most of them with two inspectors each, operating 16 hours a day. This extended the road-patrol system to the most important exit highways.

When the seasonal restrictions on fruits and vegetables became operative on June 15, four additional stations were opened in Virginia. Inspection personnel was increased durng June, and full quotas of men were assigned to the posts by June 24.

At the end of the year there were in operation 36 road stations. Of this number 1 was on the Maryland-West Virginia line, 8 were in Ohio, 11 in Pennsylvania, 11 in Virginia, and 5 in West Virginia. Seven mobile inspectors were employed in Pennsylvania. Roving inspectors were also assigned to cover various highways in the vicinity of Ravenna, Ohio.

Trucks returning to southern points after driving through sections in which beetles were swarming were again found to contain large numbers of living beetles. Finds ranging from 10 to 30 beetles were common. Fifty-three lots of infested plant material were stopped at the posts, from which were removed 12 adults, 113 grubs, and 2 pupae.

Counts of all motor vehicles stopped at the road stations for inspection during the year totaled 4,661,663. Uncertified quarantined products were found in 24,848 vehicles.

CERTIFICATION AND TREATMENT OF NURSERY STOCK

Owing to increasing beetle infestations, summer scouting in 1937 in the regulated zone revealed additions to the number of nurseries and greenhouses found to be infested with the Japanese beetle. Commercial and noncommercial establishments found infested in the New England sector totaled 15, and in the New York City area 32, of which 27 establishments were located on Long Island. In the Baltimore area infestations were found on the premises of 53 nurseries and greenhouses, and within a 500-foot radius of 11 others. Additional infestations on classified establishments were found in six Virginia nurseries and one each in Delaware, Ohio, and the District of Columbia, three in Pennsylvania, and nine in New Jersey. Definite increases in beetle population were found in the Philadelphia, Pa., area, and continued through the bean-growing area of Maryland and the Eastern Shore of Virginia.

Sixty-seven nurseries, located in lightly infested sections that had been found infested with one or a few beetles in previous years, were rescouted during the summer of 1937 to determine whether they might be eligible for restoration of their uninfested status. Nine entire establishments and four out of five units of a tenth establishment were found uninfested and were restored to a preferred status of classification.

Nursery and greenhouse scouting was completed by the middle of September. Seasonal restrictions on the movements of farm products from the regulated areas were lifted on September 22, 1937.

About 987 soil samples collected from 94.9 acres of nursery plots, heeling-in areas, and frames treated with lead arsenate were analyzed by the Division of Insecticide Investigations to determine the concentration of the poison in the soil. Initial applications of lead arsenate were made to 22 acres of nursery plots and heeling-in sections.

Commercial establishments conforming to the requirements for classification increased from 2,365 to 2,514. Divided on the basis of classification, 1,837 of these establishments were in class I, 672 in class III, and 5 in intermediary classification. The number of uninfested nurseries increased by 116. There was a net decrease of 33 in the number of infested classified establishments, due to the fact that many establishments relinquished their classification when found infested.

CERTIFICATION OF FRUITS, VEGETABLES, AND CUT FLOWERS

One hundred and eighty-nine inspectors inspected fruits and vegetables during the period of adult beetle flight in 1937. Throughout the regulated area 39 inspection centers were in operation—1 each in Connecticut, the District of Columbia, Maine, and Ohio; 2 each in Massachusetts and Pennsylvania; 4 in New Jersey; 5 in Virginia; 6 in Maryland; 7 in New York; and 9 in Delaware.

Inspection of all south-bound fruits and vegetables was again centralized this season at Fredericksburg, Va., to eliminate the possibility of reinfestation of certified produce moving through the restricted region.

Imposition of stricter fumigation and loading requirements on the movement, from the heavily infested areas of New Jersey, Pennsylvania, Delaware, and

Maryland, of refrigerator cars containing fruits and vegetables resulted in the transportation of fewer living beetles in the bunkers of these cars than last year. Examination of hundreds of refrigerator cars upon their arrival at midwestern terminals from the eastern points resulted in the finding of 32 living beetles distributed among 20 cars. Nineteen of these infested cars were from the Eastern Shore of Maryland and Virginia and one was from southeastern Pennsylvania. Ninety-seven living beetles in 70 cars were found during similar terminal inspection in the summer of 1936.

Fumigation of banana refrigerator cars with hydrocyanic acid in the New York City area was started on July 6, 1937.

Requirements for the fumigation of refrigerator cars for potato shipments and for the screening of cars were lifted on September 1, 1937, since the number of beetles had decreased sufficiently at or near the vicinity of loading points. The seasonal restrictions on fruits and vegetables were removed September 21, but the restrictions on cut flowers remained in effect until October 15.

Fumigation of cars was concluded at the end of August. During the season 16,507 cars were fumigated, containing a total of 37,810 units of farm products.

Administrative instructions approved April 30, 1938, authorizing fumigation with methyl bromide of potatoes in refrigerator cars permitted fumigation of the loaded cars at Wilmington, Del., and Philadelphia, Pa., the principal diversion points. During the last half of June alone 735 carloads of such potatoes were treated under this method.

During the period of the seasonal quarantine on fruits, vegetables, and cut flowers inspectors removed adult beetles from 7,550,977 packages of commodities certified for transportation.

CERTIFICATES ISSUED, VIOLATIONS INVESTIGATED, AND PROSECUTIONS TERMINATED

To cover quarantine products moving to nonregulated territory for the year, 722,421 certificates of all types were required.

Table 3 shows the quarantined articles intended for shipment from the regulated area and for use in certified greenhouses or surface soil plots, in heeling-in areas, or in plunging areas, which were fumigated or sterilized during the 12-month period.

TABLE 3.—*Materials fumigated or sterilized under Japanese beetle quarantine regulations, fiscal year 1938*

Treatment	Plants	Potting soil	Sand		Surface soil	Surface soil with plants	Berries	Potatoes		Onions
	Number	*Cubic yards*	*Cars*	*Cubic yards*	*Square feet*	*Square feet*	*Crates*	*Cars*	*Bags*	*Cars*
Lead arsenate	252,895	20			645,437	3,509,413				
Carbon disulphide gas or emulsion	8,791	3,869	103	4,179	36,051		5,524			
Naphthalene		73			58,076					
Steam		419								
Hydrocyanic acid								26	7,704	
Paradichlorobenzene	260,630									
Methyl bromide								735		1

	Bananas		Cucumbers		Tomatoes		Peppers		
	Bunches	*Cars*	*Bushels*	*Cars*	*Cars*	*Baskets*	*Bushels*	*Hampers*	*Cars*
Hydrocyanic acid	6,625	18	4,650	11	6	4,239	1,563	2,775	5

	Onions	Eggplant	Empty cars	Peaches		Sweetpotatoes	
	Cars	*Bushels*	*Number*	*Bushels*	*Cars*	*Hampers*	*Cars*
Hydrocyanic acid	25	239	12,414	390	1	10,869	30

Nursery and ornamental stock, sand, soil, earth, peat, compost, and manure were certified for shipment from the regulated areas during the year in the following quantities:

Plants	number	29,676,383
Sand, earth, and clay	carloads	4,203
Peat	do	5
Compost and manure	do	181

Fruits, vegetables, moss, and cut flowers certified during the seasonal quarantine on these articles were as follows:

Fruits and vegetables	packages	7,462,436
Moss	bales	2
Cut flowers	packages	88,541

Apparent violations of the Japanese beetle regulations investigated by the Bureau totaled 2,436.

Convictions for transporting quarantined materials from within the heavily infested area to outside destinations without inspection and certification were secured against 18 truckers transporting farm products. Seventeen were intercepted at Rochester, N. Y., the other at Buffalo, N. Y. One corporation was fined for the misuse of Japanese beetle certificates in shipping ivy plants from New York City to Florida. One nurseryman was fined $100 for a series of violations involving the mailing of uncertified plant material. Fines were imposed by the New York State Department of Agriculture upon three truckers for intrastate quarantine violations.

COOPERATIVE ENTERPRISES

The following States in nonregulated territory provided funds or labor for cooperative control or quarantine activities: California, Colorado, Georgia, Illinois, Indiana, Kentucky, Michigan, Missouri, and North Carolina.

The city of St. Louis, Mo., also contributed funds for the trapping program. Charlottesville, Va., arranged for treatment of its infested area. A Bag the Beetle Day in Harrisburg, Pa., procured 2,000,000 beetles in 2 days during July 1937 .

Cooperative control or quarantine activities in the regulated area again received State funds from Connecticut, Delaware, Maryland, Massachusetts, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Virginia, and West Virginia.

The total contributions from Federal welfare, State, and city agencies for labor and materials used to set and remove traps were approximately $32,500.

Experimental work with the nematode *Neoaplactana glaseri* in controlling established infestations of the Japanese beetle was continued at the laboratory at White Horse, N. J., under the joint cooperation of this Bureau and the New Jersey Department of Agriculture. The principal work related to the rearing of nematodes on artificial media until ingestion by the host and a new method of uniform application of the nematodes into the soil. This work was financed by an allotment of $3,000 of Federal and $9,000 of State funds.

INFORMATIONAL ACTIVITIES

In addition to sharing interest with other insect pests at four exhibits and in the September release of the March of Time, the Japanese beetle was the exclusive subject of an attractive exhibit set up at the International Flower Show, March 14–19, at the Grand Central Palace, New York City.

CONTROL OF PHONY PEACH AND PEACH MOSAIC DISEASES

The phony peach and peach mosaic projects were consolidated at the commencement of the year and field headquarters were established at Little Rock, Ark. By uniting the control operations relating to these two peach diseases, overlapping of two inspection forces was eliminated by training inspectors in both fields. Inasmuch as the diseased areas overlap in the southern midcontinent area, the union of the projects was desirable.

Inspection of nearly 10,000,000 cultivated host trees on over 88,000 properties in 21 States was carried on during the year. Trees to the number of 21,523 were found infected with phony peach disease, and 24,727 diseased trees, including some carry-overs, were destroyed. Mosaic trees to the number of 57,155 were discovered and 47,919 had been removed by the close of the year.

Inspection was conducted in Alabama, Arizona, Arkansas, California, Colorado, Georgia, Illinois, Indiana, Kentucky, Louisiana, Maryland, Mississippi, Missouri, New Mexico, North Carolina, Oklahoma, Pennsylvania, South Carolina, Tennessee, Texas, and Utah. No trees affected with phony peach or peach mosaic were found in Indiana, Maryland, or Pennsylvania. Peach mosaic was reported this year in seven additional counties, one in Colorado, four in Texas, and two in Utah.

Escaped and abandoned peach trees are dangerous harboring grounds for these diseases, and nearly 500,000 abandoned trees and over 4,000,000 escaped trees were destroyed during the year.

One of the methods of spread of these diseases is by shipments of infected nursery stock. To reduce this risk all nursery stock and, in the case of peach mosaic, all budwood sources and their environs in the infected States are inspected annually. Movement of stock is permitted by the States only when the nurseries meet the requirements of the standard State quarantines relating to these diseases.

Research has developed the fact that certain varieties of stone fruits are or may be symptomless carriers of peach mosaic. Accordingly, the plum trees in and surrounding the heavily infected area in Mesa County, Colo., were indexed with healthy peach scions. These peach grafts will act as a permanent indicator of the health of the plum trees, thereby permitting their annual inspection.

Results of inspection during the field season of 1937 showed a reduction, in number of trees infected with the phony peach disease, of 50 to 100 percent in the lightly infected States and a reduction in the generally infected States.

This project has been substantially assisted by allotments from Federal emergency relief appropriations and is carried on in close cooperation with the plant pest-control departments of the States concerned.

CITRUS CANKER ERADICATION

Inspection of citrus trees for citrus canker was carried on during the year, jointly with the States, throughout the citrus-growing areas of Louisiana and Texas, two Gulf coast counties of Alabama, and the adjacent area in western Florida. In Louisiana and Texas, the only States in which the disease is known to exist, repeated inspections were made of all areas found infected since the intensive campaign of 1935, and inspections were also extended into a number of other counties. No new areas were found infected. Canker was found recurring on 12 properties in the noncommercial areas of these States. The 103 infected trees consisted of 1-year seedlings in the case of all properties in Texas and one property in Louisiana.

One of the most important phases of citrus canker eradication consists in the removal of escaped and abandoned trees to prevent their becoming a harboring place for the disease. The success of this phase of the project was aided materially by allotments from emergency relief appropriations. In some areas in these States extensive plantings of nursery stock were set out in past years and later abandoned as an unprofitable undertaking. From these nurseries and abandoned orchards an extensive seedling spread has developed. Trees of this type, to the extent of over 2,500,000, were destroyed in the above-mentioned States during the year, to prevent their becoming a harboring place for citrus canker.

INSECTS AFFECTING FOREST AND SHADE TREES

ADVICE AND COOPERATION IN THE CONTROL OF FOREST INSECTS

The major part of the work of the Division of Forest Insect Investigations was again devoted to problems associated with the control of the various species of bark beetles which attack forest trees. Large areas of timberland were surveyed to determine the amount of insect infestation and thus obtain data upon which to base reports and recommendations as to the need for control work. On some of the larger projects entomologists were assigned to give technical advice during the execution of the control operations.

SURVEYS

Over 12,000,000 acres was covered with surveys which, in addition to serving as a basis for control work, furnished valuable technical information on the

characteristics of trees attacked by bark beetles, the relative susceptibility of various stands, and the relation between beetle outbreaks and weather. All the accumulated data thus gradually acquired should prove of much value in anticipating future outbreaks.

CONTROL WORK

The surveys showed that conditions with respect to bark beetle infestations in the ponderosa pine stands of California and Oregon were much improved as compared with recent years.

The most serious situation existed in the central Rocky Mountain region, where the period of severe drought for the past several years and the correspondingly poor tree growth encouraged activities of the Black Hills beetle and allowed this insect to build up to a new peak of abundance. The largest and most spectacular battle was waged on the Roosevelt National Forest, where over 21,000 infested trees were treated. In spite of this work there was a known infestation of 9,000 additional trees on this forest, the treatment of which was prevented by the lack of men and money. On the Medicine Bow National Forest about 10,500 infested trees were successfully treated. In the Denver Mountain Parks area a cooperative undertaking, the first of its kind, was successfully brought to a close by the treatment of 7,000 infested pines by Works Progress Administration crews, National Park Service crews, and National Forest Service crews. On the Pike National Forest over 4,000 infested trees were treated. Many other smaller projects were successfully completed throughout the region. However, some infestations still remain on private and other lands where control work is badly needed in order to prevent the destruction of many thousands of additional trees in the next few years.

CALIFORNIA HAZARD SURVEY

For several years considerable control work has been directed against the western pine beetle in the overmature stands of ponderosa pine in eastern California and Oregon. This control work has been only partially successful.

With the increased funds allotted to the Berkeley, Calif., laboratory special study was centered on ways of directing cutting operations in such a way that susceptible trees and stands can be removed and utilized before they are attacked and killed by the beetles. As a step in this direction an inventory survey based on susceptibility to beetle losses as shown by growth conditions, type, maturity, and incidence of present and past beetle infestations in the stand was started in 1937. The immediate practical application of this hazard inventory is to guide owners in early cutting of those areas where heavy losses are most likely to occur, leaving the less susceptible areas in reserve. Over 500,000 acres was classified during the 1937 season. Completion of this project will require 4 years.

NEW OUTBREAK OF THE SOUTHERN PINE BEETLE

The southern pine beetle has killed a large amount of merchantable loblolly pine, roughly estimated at around 20,000,000 board feet, in a widespread outbreak which has occurred since 1936. The area involved extends from the eastern shore of Maryland and Virginia to North Carolina. This outbreak developed following a deficit of several inches of rainfall in the spring and summer of 1936. There was also a deficit for a part of 1937 and the beetles showed a corresponding increase in numbers. Heavier rainfall has occurred in 1938 and it is hoped that the increased vigor of the trees will serve as a natural check upon the insects. There is need for considerable research work on this insect and its control.

RESEARCH ACTIVITIES

BARK BEETLE PREDATORS

The role of insects which feed upon and limit bark beetle populations is now being studied intensively, both in the field and in the laboratory. Much new information was secured concerning the two most important beetle predators, *Enoclerus lecontei* Wolcott and *Temnochila virescens* (F.), as a result of research work during the 1937 season. Experimental technique for rearing these predators under insectary control was developed.

EFFECT OF DEFICIENT PRECIPITATION ON GROWTH OF PINE TREES AND OUTBREAKS OF THE BLACK HILLS BEETLE

During the year studies on the Black Hills beetle in the Rocky Mountain region showed that there is a positive correlation between drought periods as shown by slow growth rate of the pines and outbreaks of this insect. Precipitation data were copied from United States Weather Bureau records for long periods preceding, during, and following individual outbreaks. Increment cores were taken from a large series of trees in areas where the outbreaks occurred, and the annual radial growth measured from 1915 to the present time. The data show that in the Rocky Mountain region the growth rate of pines is directly dependent on the amount of precipitation. From 1915 to 1923 precipitation averaged considerably above normal and the tree growth was correspondingly good. From 1924 to 1929 precipitation was slightly below normal and tree growth declined accordingly. From 1930 to the present time general drought conditions have prevailed, tree growth has been poor, and epidemics of the Black Hills beetle have been numerous and serious. These outbreaks have begun during periods of severe drought and relatively poor tree growth and have continued to build up to serious proportions throughout a prolonged period of similar critical conditions.

THE FOREST TENT CATERPILLAR

The forest tent caterpillar has continued to occur in outbreak numbers in various sections of the country, especially in New England and northern Minnesota. Much damage has been done to sugar maple orchards in Vermont and New Hampshire. There was a very large egg population throughout most of northern Minnesota in the winter of 1937–38, but as a result of early hatching, followed by cold weather, which delayed foliage development, mortality among the newly hatched larvae this spring was heavy.

THE PANDORA MOTH IN LODGEPOLE PINE IN COLORADO

The pandora moth, a serious pest of yellow pines in California and Oregon, was found severely defoliating an area of about 80,000 acres of lodgepole pine on the Arapaho National Forest, Colo. The lodgepole in many centers of heavy defoliation already appears doomed. Areas for survival plots have been selected in the infestation, and preliminary studies were begun last year on the life history and biology, although little is yet known about the method of control.

THE SPRUCE BUDWORM IN PONDEROSA PINE IN COLORADO

For the first time several distinct outbreaks of the spruce budworm have been found in pure stands of ponderosa pine. Preliminary studies on this apparently new biological strain of the budworm showed that it limited its activities entirely to ponderosa pine and that it not only severely reduced the growth of infested pines but also killed many laterals and terminals, and its continuance threatens the existence of the attacked trees. The biology of, and control methods for, this new forest pest are being worked out.

SCALE INSECTS

Field studies of the Prescott scale (*Matsucoccus* sp.), which attacks ponderosa pine in Arizona, have further demonstrated the connection of this insect with the killing of twigs known as "flagging." Experiments demonstrated that flags can be produced by artificially planting large numbers of scales on trees which have previously been free from this injury. Investigations with a species of *Matsucoccus* which attacks pitch pine indicate that certain enzymes secreted by the salivary glands of the insect will cause death of the tissue when injected into the twigs.

INSECTS AFFECTING PERSIMMON

Work was started in the spring of 1938 on a study of insects affecting persimmon trees. This work was necessary because of the discovery, in 1937, of a new disease of persimmon which may possibly be transmitted in some way by insects. The life histories and habits of the various insects, particularly borers, which affect persimmon are being studied in an effort to discover any possible relationship of insects with the disease.

HEMLOCK BORER

The hemlock borer has infested a large amount of the eastern hemlock which has died in parts of northern Wisconsin and the Upper Peninsula of Michigan during the last 2 or 3 years. It is believed that this insect is secondary in its action, in that it is attacking trees which are very much overmature or are weakened as the result of severe drought conditions. Work was started in 1937 to determine the part played by the borer in the deterioration of these hemlock stands.

TERMITE CONTROL

Termite investigations were conducted along two lines, (1) the inspection of commercially treated structures before and during treatment, so as to observe the practices, as well as to follow up the efficacy of the chemicals used, and (2) the treatment of buildings so as to determine more specifically the value and costs of various soil poisons which may be used under certain conditions in place of, or as a supplement to, the more desirable and permanent structural changes. Individual records were obtained concerning 185 buildings treated by 14 commercial companies and 95 buildings treated by the Bureau's personnel, 12 different chemicals or mixtures being used.

POWDER-POST BEETLES

Studies of *Lyctus* powder-post beetles indicate that hardwood lumber may possibly be made resistant to attack by modifications in seasoning practices, combined with changes in the time of year of felling. This has special significance in relation to supplying foreign markets with *Lyctus*-free timber.

AMBROSIA BEETLE DAMAGE IN FELLED TREES

As a result of heavy losses from ambrosia beetles or pinhole borers in Douglas fir-logging operations of western Oregon and Washington, studies were conducted to determine practical methods of prevention or control. The period when logs may be safely left in the woods was determined, and experiments are under way to find methods of discouraging attacks after the logs have been placed in mill ponds.

CONTROL OF CARPENTER ANTS

Considerable work was done to find effective means of controlling carpenter ants, which are so troublesome in homes of the Pacific Northwest. Several fumigants and contact insecticides gave satisfactory results, provided all the ant chambers could be reached with the chemical.

INSECT VECTORS OF THE DUTCH ELM DISEASE

The results of the collection and culture of a large number of adult elm bark beetles, *Scolytus multistriatus* Marsh. and *Hylurgopinus rufipes* (Eichh.), showed that a smaller percentage of the beetles were contaminated with the fungus organism in 1937 than in 1936. In a study of the mating habits of *S. multistriatus* it was found that the fungus may be disseminated among the beetle population as a result of physical contact of the beetles.

Elm woodpiles, slash, dead trees, and broken branches serve as very favorable breeding places for elm bark beetles. Where such material is infected with the disease the adult beetles which emerge may carry spores to healthy trees and inoculate them with the disease.

Studies made on overwintering larvae showed that the total mortality amounted to 88 percent. Death of the larvae was due to crowding, bark and wood conditions, woodpecker feeding, weather conditions, and other factors. Injury to the bark by woodpeckers in their search for larvae was found to be a good guide to bark beetle attack.

Experiments were continued to determine how to kill undesirable elms satisfactorily so that bark beetles will not breed in them. Introducing copper sulphate dissolved in water into the sap stream from May to September, inclusive, gave best results.

Observations and experiments were conducted to ascertain to what extent insects develop in elm stumps and whether such development can be prevented

by applying chemicals to the stumps. Bark beetle galleries were not common in the stumps. Attack and development of cerambycid and ambrosia beetles occurred generally both in untreated stumps and in those to which the chemicals had been applied.

GYPSY MOTH AND BROWN-TAIL MOTH CONTROL

Regular funds were supplemented by allotments from emergency appropriations totalling $1,297,011 and provided for Federal W. P. A. work on the gypsy moth in Vermont, Massachusetts, Connecticut, New York, New Jersey, and Pennsylvania. No emergency funds were made available for brown-tail moth work, and the intensive project on that insect that had been carried on during the previous 2 years was discontinued.

Of the W. P. A. funds allotted, 91.8 percent was paid in wages and more than 98 percent of all workers employed were drawn from relief rolls. The average number of workers employed during the first half year was 1,818. From January 1 to June 30, 1938, the average dropped to 1,276. Allotments for administrative expenditures amounting to $28,400 were also provided.

At the beginning of the year personnel was furnished from 20 C. C. C. camps for gypsy moth work in territory between the barrier zone and the Connecticut River in New England. The number has been decreased to 11 camps. There was a reduction from the previous year, averaging about 50 percent, in the emergency funds available for work on this project. This caused the work, except in New Jersey and Pennsylvania, to be confined to the barrier zone in New York and New England and to points where the most severe infestation occurred directly east of the zone.

The impossibility of using men on emergency funds or those in C. C. C. camps in places at all remote from their homes or the camps made it impossible during the year to cover some of the territory where the work should logically be done.

Spraying equipment which was reaching the stage of obsolescence was rebuilt, and improvements made in other equipment. Work was continued on the development of distributing apparatus to use in an autogiro for effectively treating forest areas by spraying from the air.

Cooperation was maintained with the Northeastern Forest Experiment Station in connection with systematic thinning of selected areas to reduce the percentage of food plants favored by the gypsy moth without seriously injuring the value of the woodland stand or eliminating the more useful species. Plots covering over 240 acres were treated and are under observation.

An attempt was made to determine the value and accuracy of estimating the degree of defoliation by observing and recording existing conditions from an autogiro. There are distinct advantages in doing the work in this way instead of by ground survey, and if this plan can be further developed it is believed that the record of defoliation can be more accurately and economically made.

Defoliation by the gypsy moth in territory east of the Connecticut River in the summer of 1937 covered 608,000 acres, a larger acreage than previously recorded. This was particularly serious in Maine and Massachusetts, where many thousands of acres of solid woodland growth, in addition to shade and ornamental trees on roadsides and home grounds, were completely defoliated in midsummer. Considerable acreage was affected in New Hampshire. A relatively small acreage of feeding by this insect occurred in territory between the Connecticut River and the barrier zone, and no evidence of feeding was reported in the zone or in New York, New Jersey, or Pennsylvania.

The deposit of egg clusters in the summer of 1937 was heavy in many areas, but only a small number were noted in sections where complete defoliation occurred. Most of the egg clusters were normal or above normal in size, indicating heavy defoliation in 1938. The winter of 1937–38 was unusually mild, with a moderate snowfall, and there was every prospect that a high percentage of the eggs would hatch in the spring. Early in April the weather was unseasonably warm and hatching occurred earlier than usual. This was followed by cold, wet weather accompanied in many sections by heavy frosts. In consequence, mortality of small larvae during this period was very high and hence the acreage defoliated in the summer of 1938 may be considerably reduced. In spite of unfavorable weather for spraying during the last part of May and in June, 70 sprayers were operated and the larger portion of the program was carried through.

In July 1937 assembling cages to the number of 2,142 were placed in the field in southern New York, 97 cages were placed in 5 towns in New Jersey where it was believed infestation was most likely to occur, and 984 cages were placed

in 13 towns in Pennsylvania beyond the outside rim of the area known to be infested. Five male moths were caught at three cages in the eastern part of Putnam County, N. Y., not far from known infested territory. No moths were secured in Pennsylvania or New Jersey. Sufficient material was collected in the summer of 1938 for use in 7,100 cages.

SCOUTING AND TREATMENT FOR THE GYPSY MOTH

Work in Maine was confined to intensive scouting of sites of infestations discovered in 1937 in Baileyville, Calais, Cooper, Indian Town, Machiasport, Princeton, Topsfield, and Trescott, all in Washington County not far from the Province of New Brunswick, Canada. Of the 4 infestations found, 2, each consisting of a single egg cluster, were discovered in the residential section of Calais, and 2, totaling 28 egg clusters, were located in the town of Princeton. All egg clusters were destroyed by creosoting, and it is hoped that these infestations have been exterminated.

The Division of Plant Protection of the Department of Agriculture of Canada carried on scouting in the Province of New Brunswick across the international border from the infestations in Maine. A number of small infestations were found in St. Stephen and adjoining territory, and thorough clean-up measures were applied.

In Vermont most of the W. P. A. funds allotted to the State were used in scouting within the barrier zone and immediately to the east where the threat to the zone appeared greatest. Most of the infestation in the State is in the Connecticut River Valley, the insect being found in many localities from the Massachusetts line north to Barnet. Scouting was done in Rutland and surrounding towns east of the zone, and in Ludlow, Mount Holly, and Shrewsbury clean-up work was applied in several small colonies found during the winter. No infestation was found in the barrier zone. The sites of infestation discovered near the Canadian border at Essex and Derby during 1936 were again intensively checked, with negative results. No spraying was undertaken in Vermont this season.

In Massachusetts scouting, the removal of favored food plants by selective thinning, burlapping, and spraying were performed in the barrier zone and a few towns to the east where wind spread into the zone seems most likely to occur. In the area between the zone and the Connecticut River infestation is present and in many places exceedingly heavy. In the zone area more infestations were discovered than during the preceding year. Most of them were in the southern portion. From their small size and scattered distribution it seems probable that these infestations were established as a result of wind spread from the east and south some 2 or 3 years ago. Eight sprayers were used in the Massachusetts barrier-zone area and five in treating infestations threatening the zone to the east.

In Connecticut W. P. A. and regular funds available were used chiefly in the barrier-zone area and most of this work was confined to Litchfield County where, because of insufficient labor in 1936 and 1937, infestation has increased. Eighteen sprayers were used in treating infestations found in this county. In the southern part of the zone in Connecticut infested areas were not found.

About 85 percent of the W. P. A. scouting and clean-up work was done throughout the entire barrier-zone area and 15 percent east of the zone.

In New York intensive scouting was done in selected areas by Federal W. P. A. forces, C. C. C. camp enrollees, and regular State employees supervised by the New York Conservation Department. The infestation discovered in Putnam Valley in 1937 was greatly reduced and only 12 small, isolated infestations were discovered in 9 other townships in the barrier zone. Early in the year a sizeable infestation was discovered in the township of Hague and 14,865 egg clusters were located and destroyed. The infestation found in the town of Shawangunk, Ulster County, in 1937, was so reduced that extermination in the near future seems likely. No infestation was found in the Borough of the Bronx and only 11 infestations, totaling 173 egg clusters, were located and destroyed in Nassau County on Long Island. Twelve Federal and five State sprayers were used in spraying the infestations discovered in New York. Fourteen hundred shipments originating in the area in Nassau County, regulated on account of the gypsy moth, were inspected and certified as free from this insect.

A small force of W. P. A. workers supervised by New Jersey gypsy moth employees performed intensive scouting in selected areas in Morris and Union Counties. The State force also made a special survey in 37 townships or municipalities in northeastern New Jersey. No evidence of the gypsy moth was found in the State.

In Pennsylvania scouting and treatment were continued in Lackawanna, Luzerne, Carbon, Monroe, Pike, and Wayne Counties. As usual first attention was given to an examination of the lowlands bordering the Susquehanna and Lackawanna Rivers within the area where infestation was first found in this region. Both sides of these rivers, as well as the islands, were covered for 31 miles. No infestation was discovered along the Susquehanna River but two infestations were found on the Lackawanna River not far from its confluence with the Susquehanna near Pittston. Although infestation was discovered for the first time in the township of Damascus, Wayne County, and in Paradise Township, Monroe County, conditions in the outside territory as a whole have improved. No infestation was found at sites of 38 outlying infestations discovered during the fiscal year 1937, and it seems certain that further treatment will not be required in many of these areas. Twenty-seven sprayers were used in the Pennsylvania area during the season just closed in treating the most serious of the infestations found.

The fourth revision of the State of Pennsylvania Quarantine on Account of the Gypsy Moth was put into effect February 15, 1938, and provides some modification of the quarantine. During the year 63,281 shipments were inspected and certified as free from the gypsy moth and 15,464 shipments were allowed to move under permit. A total of 136 egg clusters were located and destroyed on shipments offered for inspection.

The condition of the area in Pennsylvania that has been infested for the longest time has improved. A few large colonies were found but no defoliation has been reported since the work in Pennsylvania began after the original infestation was discovered.

GYPSY MOTH WORK BY CIVILIAN CONSERVATION CORP CAMPS

For the last 5 years men have been detailed from C. C. C. camps for work on the gypsy moth project in New Hampshire, Vermont, Massachusetts, and Connecticut, the principal purpose being to examine territory between the barrier zone and the Connecticut River and apply treatment to infested areas to protect the barrier zone from reinfestation. During this period most of the territory mentioned has been examined by these men or by W. P. A. employees supervised by the Bureau. Many areas, however, have not been scouted owing to their distance from the camps or from points where W. P. A. men were available. The camp force available for gypsy moth work reached its peak in 1936 and since then has decreased, the number available in the fiscal year 1938 being 50 percent less than in the previous year. At present 80 men are available from 2 camps in Vermont, 290 men from 4 camps in Massachusetts, and 130 men from 5 camps in Connecticut; in all, 500 men.

Intensive treatment, including selective thinning of woodland, was carried on chiefly in the areas where the heaviest infestations existed that were within the allowed distance from the camp concerned. On account of the reduction in C. C. C. force, including a drastic cut in supervision, it was necessary to concentrate the work where it could be reached by the camps regardless of pressing work in more remote areas.

Some work was carried on in 70 towns, as follows: 17 in Vermont, 23 in Massachusetts, 26 in Connecticut, and 4 in New Hampshire. Infestations were found in 58 towns. Work was done in 525 infestations, 47 of which appear to have been exterminated, since careful follow-up work has failed to show any signs of the pest. Most of those exterminated were in Connecticut, where the colonies were small and isolated and where it was possible to carry on the work without interruption.

Because no spraying equipment was available in the C. C. C. organization, a large quantity of burlap was used as a partial substitute. Burlapping is very useful, not only in heavy infestations but in sparsely infested areas. In spite of the large volume of work done in the territory between the Connecticut River and the barrier zone, the insect increased in many localities. Small infestations were eradicated and even very severe ones were greatly reduced in intensity, and this gave added protection to the barrier zone and lessened the danger of westward spread. In local areas where intensive work was done the infestation was reduced. Thinning work improved forest conditions and left many areas less susceptible to infestation and damage. Cooperation was maintained throughout the year with the United States Forest Service and various State officials charged with the maintenance and general operation of the camps.

Table 4 gives a consolidated report of scouting and treatment work done by the Bureau during the year.

TABLE 4.—*Gypsy moth control work, fiscal year 1938*

State	Project	Scouting							Thinning		Fencing		Banding			Spraying		
		Open country scouted					Woodland scouted	Egg clusters creosoted	Woodland thinned	Trees cut in open	Wire erected	Wire removed	Burlap bands applied	Pupae crushed	Larvae crushed	Woodland sprayed	Residential properties sprayed	Trees in open sprayed
		Open areas	Road	Apple trees	Oak trees	Shade trees												
		Acres	*Miles*	*Number*	*Number*	*Number*	*Acres*	*Number*	*Acres*	*Number*	*Feet*	*Feet*	*Number*	*Number*	*Number*	*Acres*	*Number*	*Number*
Maine	Regular	6,750	40	6,150	101	8,245	2,622	30	0	0	0	0	0	0	0	0	0	0
New Hampshire	C. C. C	10,025	43	2,765	0	2,225	21,830	0	0	0	0	0	0	0	0	0	0	0
Vermont	W. P. A	258,389	1,260	243,535	31,748	678,333	310,806	26,860	138	1,215	0	121,064	5,204	33,331	64,633	0	0	0
	C. C. C	21,251	163	28,625	11,399	64,263	50,699	425,599	352	448	0	0	104,486	205,082	1,214,169	0	0	0
Massachusetts	W. P. A. and regular.	43,554	452	67,403	9,265	115,233	99,186	71,039	646	85	380,606	363,637	77,711	992,007	572,563	2,316	26	336
	C. C. C	9,726	133	27,646	11,243	22,349	42,622	3,368,992	1,401	8,674	0	0	349,363	1,654,778	6,487,167	0	0	0
Connecticut	W. P. A. and regular.	88,746	1,034	158,688	59,807	191,179	143,953	14,617	1,077	0	61,800	3,600	146,720	5,590	9,981	3,492	0	200
	C. C. C	24,358	267	74,616	11,312	75,832	65,598	28,223	80	403	0	0	163,175	5,253	69,206	0	0	0
New York	W. P. A	22,565	218	49,770	27,578	171,005	29,646	14,554	703	0	7,931	0	35,482	0	25,532	483	0	60
	State and C. C. C.	289,396	2,190	612,134	0	5,853,800	219,108	1,070	1,546	0	0	0	226,624	0	0	3,354	0	5,454
New Jersey	W. P. A	468	12	5,268	194	5,622	2,269	0	0	0	0	0	2,880	0	0	0	0	0
Pennsylvania	W. P. A	84,178	846	161,724	91,633	615,178	173,896	215,151	1,727	81	201,716	173,188	598,981	55,055	162,810	5,166	2,091	75,596
Total	W. P. A. and regular.	[1] 794,046	[1] 6,052	[1] 1,304,672	220,326	[1] 7,638,645	[1] 981,486	[1] 343,321	[1] 5,837	1,381	652,053	661,489	[1] 1,003,602	1,085,893	835,574	[1] 14,721	2,117	[1] 81,646
	C. C. C	[2] 65,360	[2] 606	[2] 133,652	33,954	[2] 164,669	[2] 180,659	[2] 3,822,724	[2] 1,833	9,525	0	0	[2] 617,024	1,865,116	7,770,542	0	0	0
Grand total		859,406	6,658	1,438,324	254,280	7,803,314	1,162,145	4,166,045	7,670	10,906	652,053	661,489	1,620,626	2,951,009	8,606,116	14,721	2,117	81,646

[1] Including State and C. C. C. in New York.
[2] Not including C. C. C. in New York.

GYPSY MOTH AND BROWN-TAIL MOTH QUARANTINE ENFORCEMENT

CERTIFICATION OF QUARANTINED PRODUCTS

An increase was noted in the number of gypsy moth egg clusters removed from products offered for inspection and certification. Many wood lots from which quarantined products previously had been moved on the basis of freedom from infestation of the area involved disclosed infestation, thereby greatly increasing the amount of piece-by-piece inspection of forest and evergreen products.

In the course of the year inspectors removed 1,382 egg clusters, 102 larvae, and 25 pupae from material examined prior to removal to noninfested territory. Finds of from 25 to 50 egg clusters on a single carload shipment of lumber were not uncommon. The most heavily infested shipment examined during the year was a carload of lumber inspected at Brownfield, Maine, for movement to Syracuse, N. Y. The inspector removed 116 egg clusters from the boards in this shipment.

Reduction in certification activities in a number of sections in the northwestern part of the regulated zone permitted a realignment and a reduction in the number of districts assigned to individual inspectors. The area is now divided into 18 instead of 21 districts. Inspectors thus released were transferred to districts requiring extra men.

Rules and regulations governing the movement of quarantined products continued as last revised on November 4, 1935. A revised administrative order issued September 13, 1937, added a few items to the articles already exempt from the quarantine restrictions.

Shipments of evergreen boughs started about November 10, and movements of Christmas trees began on November 15. In western Massachusetts and southern Vermont inspection of evergreen-bough lots was practically completed by the end of November. Christmas-tree inspections continued through December 15. Tabulation of certification records for the Christmas-tree shipping season of 1937 shows a 20 percent increase in the number of trees inspected. Compared with 634,365 trees inspected in the fiscal year 1937, this year's total was 763,062.

There was a considerable increase in the certification of material intended for manufacture into Christmas wreaths and decorative pieces. Many tons of fir balsam boughs, later cut into small pieces for use in Christmas wreaths, required individual inspection. In some instances balsam boughs were found so heavily infested that they could not satisfactorily be rid of egg clusters, and certification was denied.

Temperatures above normal in March and April resulted in the hatching of egg clusters late in April in all New England States except Maine and Vermont. In the latter States hatching started about May 5. Observations by district inspectors in June indicated that defoliation in the woodlands in many districts of the infested area was lighter this year than in the past several years. Unusually early hatching of the eggs in the spring, followed closely by late frosts, caused a heavy mortality among the young larvae.

Sixteen egg clusters, 17 larvae, and a pupa were removed from 24,856 lots of nursery stock certified during the year. Nursery products shipped under certification were as follows:

	Number
Shrubs	2,516,169
Specimen trees	46,194
Young trees	254,095
Specimen evergreens	255,311
Young evergreens	2,142,866
Seedlings, cuttings, and small plants	4,066,330
White pine trees	321,599

Most of this material was jointly certified in compliance with both the Japanese beetle and the gypsy moth quarantine regulations.

Table 5 gives summaries of the quantities of quarantined products other than nursery stock certified during the year.

TABLE 5.—*Evergreen products, forest products, and stone and quarry products certified under gypsy moth quarantine, fiscal year 1938*

Material	Quantity	Certificates issued	Gypsy moths found		
			Egg clusters	Larvae	Pupae
Evergreen products:					
Boughs, balsam twigs, and mixed greens		*Number*	*Number*	*Number*	*Number*
boxes or bales	51,837		58		
Christmas trees—number	763,062				
Laurel—boxes or bales	12,508				
Miscellaneous—boxes	4,979				
Do—feet, roping	6,218		5		
Do—truck loads	2				
Total		18,837	63		
Forest products:					
Barrel parts, crates, crating—cases, bundles	6,238				
Logs, piles, posts, poles, ship knees, and ties—pieces	2,048,722		78	21	7
Fuel wood—do	3,350		78		
Miscellaneous wood—do	1,549		6		
Pulpwood—cords	54,632		227		
Lumber—board feet	40,394,301		880	[1] 63	9
Empty cable reels—number	22,524			1	5
Shavings—bales	40,509				
Shrub and vine cuttings—boxes	3,938		2		
Lags—bundles	9,256				
Miscellaneous—pieces	449,665		2		
Do—carloads	41		13		
Do—trucks	2		9		
Total		20,213	1,295	[1] 85	21
Stone and quarry products:					
Crushed rock—tons	482				
Curbing—running feet	37,155				
Feldspar—tons	15,215				
Granite—pieces	152,044				
Do—tons	11,263		8	0	3
Monumental stone—do	22,035				
Grout—do	38,763				
Marble—pieces	299				
Paving blocks—number	1,098,504				
Miscellaneous—pieces	30,084				
Do—tons	138				
Do—carloads	6				
Total		22,787	8	0	3

[1] 1 female moth.

VIOLATIONS

Apparent violations of the gypsy moth and brown-tail moth quarantine investigated numbered 1,140.

From November 20 to December 23, while shipments of Christmas trees were moving from the gypsy moth regulated area to New York City via freight and truck, four inspectors were temporarily stationed in the city to check on the certification of trees upon their arrival. Several truckloads of uncertified trees were intercepted and their return to the infested area accomplished. Three Connecticut truckers failed to return their loads to the point of origin and were prosecuted. One conviction carrying a $25 fine was obtained. Two cases were pending at the end of the year.

DUTCH ELM DISEASE ERADICATION

GENERAL STATUS

Pronounced decreases in the number of confirmations of trees infected with the Dutch elm disease during the 1937 foliar season, coincident with earlier and more intensive scouting, afford a basis for hope for eventual eradication of this disease. Most of the main infected area is still confined to territory within a radius of 50 miles from New York City. Outside this zone of continuous infection first-record infections were limited to Athens, Ohio, and Wileys Ford,

W. Va. In Indianapolis, Ind., infections increased from 39 to 85. Negative results of the season's scouting in Cleveland, Ohio, were particularly gratifying, since they confirmed for the second consecutive year the effectiveness of the sanitation program in that city during the winter of 1935–36. Discoveries of diseased trees in Dutchess County, N. Y., extended the northernmost point of infection to approximately 70 miles from New York City and 20 miles from the southwestern Massachusetts border.

SYSTEMATIC SCOUTING

Systematic scouting during 1937 had been in progress for a month prior to the present fiscal year. From June 1, when scouts were placed in the field, until September 30, when yellowing of the leaves forced a discontinuance of the field observations, scouts located 5,497 trees which were later confirmed as infected with the fungus causing the disease. Of this total, 111 were in Connecticut, 4,215 in New Jersey, 1,136 in New York, and 35 in outside States. The only increases were of small numbers of trees in the Connecticut infected zone and at Indianapolis, Ind. New York netted a 33-percent decrease and New Jersey a 23-percent decrease, as compared with the 1936 foliar season. Total confirmations during the year reached an even 6,500. The grand total of elms in the country confirmed as infected since discovery of the disease in Ohio in 1930 is 29,625.

At the peak of the 1937 scouting season in the several States the scout force totaled 3,111, with 310 in Connecticut, 1,751 in New Jersey, 873 in New York, and 177 in outside areas. The maximum number of W. P. A. scouts in the field was 2,643.

Tentative quotas of scouts set for each State were not filled, owing to the difficulties in securing W. P. A. workers adapted to tree climbing, identification of elm and disease symptoms, and other qualifications necessary for satisfactory performance as scouts. All qualified men in sanitation crews were given an opportunity to attend scout schools, and those found satisfactory for this type of activity were transferred to scout crews.

Return to private employment of men on relief, dismissals for incompetence, and cancellation of W. P. A. workers' relief status made heavy inroads on the scout crews and necessitated the use of a lower grade of relief labor than in any previous scouting season. To offset this heavier load of inexperienced men, a larger number of trained tree workers were employed as crew foremen. The scouts were also required to give more detailed attention to elms showing any abnormal symptoms. This was particularly true in New York, where scouts on the first and second surveys sampled all elms with minor symptoms and took specimens from all English elms. Confirmation, as infected, of an English elm which showed no external symptoms except stagheadedness and only faint discoloration after repeated sampling was the occasion for the issuance to New York scouts of instructions to submit samples from each major limb of all English elms observed. Although this resulted in slower coverage of the areas, the intensified sampling lessened the risk of overlooking infected trees.

Closer attention to minor symptoms resulted in a large increase in the seasonal total of twig samples collected for dispatch to the laboratory. The record collection of the year amounted to 9,417 samples for the week ended August 21. The total of samples collected during the summer was 75,156, or a 34-percent increase for the year.

In extent the three surveys of the work area during the summer of 1937 slightly exceeded those of the previous summer. The entire work area in Connecticut was covered twice, and there was a third coverage of the infected zone plus one-fifth of the protective area. In New Jersey the work area was completely scouted on the first go-over and was entirely covered a second time except for 100 square miles scattered in the work areas of Hunterdon, Somerset, and Warren Counties. A third coverage in New Jersey was carried on in 1,681 square miles scattered throughout the work area. Two hundred square miles in the vicinity of localized disease concentrations in six New Jersey counties received a fourth go-over.

On the first survey in New York, scout screws covered the entire infected area and 25 percent of the protective zone. The second go-over in the State extended to 90 percent of the infected area. The third New York survey included approximately one-third of the known infected area.

Approximately one-third of that portion of the protective zone which extends into Pennsylvania was scouted by foot scouts, and the remainder was covered by an autogiro crew.

It is possible for the second consecutive year to cite substantial decrease in the number of confirmations. Confirmations on Staten Island have decreased from 653 in the summer of 1934 to 326 in 1935, 70 in 1936, and 32 in 1937. Similar conditions were found in the Bronx, New York City, where successive years' confirmations of 452, 334, and 185 were this year reduced to 82. In Caldwell Township, Essex County, N. J., one of the most heavily infected areas in the State, confirmations declined from 398 in 1935 and 41 in 1936 to 14 this year.

Scouting of isolated infections in 1937 was directed from field stations established in Baltimore, Md., and Indianapolis, Ind. Summer activities outside the major infected area resulted in the finding of 5 confirmations near Wileys Ford, W. Va., a single diseased tree in Athens, Ohio, and 25 additional confirmations in the Indianapolis, Ind., isolated infection. Scouts covering territory surrounding the location where a single diseased tree was found near Cumberland, Md., in 1936 discovered five infected trees near Wileys Ford. One of these was rather close to the Cumberland tree. Three additional trees confirmed as infected were closely clustered at a distance of 3 miles from the Cumberland infection, while a fifth tree was found 6 miles farther west. The diseased tree in Athens, Ohio, was found by a crew engaged in foot scouting of railroads running through an area infested with the smaller European elm bark beetle, determined last year in a partial survey of the Ohio River and some of its tributaries. This tree was located on the bank of the Little Hocking River, near the Baltimore & Ohio Railroad. About half the crown had died in 1936, and discoloration was found in the last three annual rings.

Cooperative scouting work in Indianapolis in 1937 was more efficiently supervised and more adequately manned than in any previous year. Activities in Indianapolis for most of this year were intensified under the direction of a pathologist transferred to that point from the field headquarters early in June. A handicap in previous years' operations, occasioned by the necessity for employing untrained W. P. A. scouts, was in a large measure overcome by the assignment of seven experienced tree men on Federal pay roll, each to serve as foreman of a scout crew operating in the city. Five of these crews were each supplemented by an experienced tree worker hired by the State of Indiana. In addition to the systematic scouting in Indianapolis and vicinity, an autogiro crew and ground scouts spent from September 1 to 27 in observations of suburban areas surrounding and at some distance from the city.

Following the purchase of two additional autogiros on May 17 and July 14, 1937, the autogiro scouting units were built up to four serviceable giros, with accompanying pilots, observers, and ground crews. One aerial unit scouted 11,000 miles of railroad right-of-way over which imported burl elm logs traveled from ports of entry to Midwestern veneer mills. This was accomplished by scheduled flying over southern and northern loops of connecting railroads. The railroad scouting for 1937 started on May 21 and was concluded on August 24. The three remaining aerial crews and their follow-up ground crews performed special scouting, largely confined to mountainous sections of the protective zone that are difficult to scout afoot. One crew spent most of the season in aerial observations in Orange, Rockland, Dutchess, and Putman Counties, and a portion of Westchester County, N. Y., along with a small section in the Connecticut protective zone. Two crews operated in the western strip of protective area bordering the Delaware River in New Jersey and Pennsylvania.

Additional infestations of *Scolytus multistriatus*, the principal insect vector of the disease, were found at a number of localities heretofore unreported. A scout crew located an infestation on the Indiana side of the Ohio River opposite the junction of the Green River, near Evansville, Ind. Another crew, working at Mount Vernon, Ind., found an elm infested with this species floating in the Ohio River.

Scout schools for the summer season of 1938 opened June 6 in Connecticut and New York. Approximately 275 men were trained in Connecticut. In New York 610 men reported for training. Schools started on June 7 in New Jersey, and at Easton, Pa., 15 men completed the quota on June 9. Training was also carried on in all the isolated infected areas. Systematic scouting began on June 13, and by June 18 practically all scouts were in the field.

Following resumption of scouting at isolated points of infection, 17 diseased trees were located in Indianapolis and 1 additional case was disclosed at Athens, Ohio. Previously four trees, confirmed as infected, had been observed at Indianapolis during progress of the elm-sanitation work.

First observation of early-season wilting typical of the Dutch elm disease was made in New Jersey on May 20, 1938, in Somerset County.

The one-millionth culture plate for testing elm chips for the Dutch elm disease was poured at the Morristown, N. J., laboratory on May 13; the first was poured there on June 5, 1934. During 1937 a total of 338,152 plates were poured.

For the year the number of samples collected from trees showing apparent symptoms of the disease was 101,869. Upon examination of the cultures 6,500 of these were confirmed as infected with the Dutch elm disease. Listed by States, confirmations were as follows: 154 in Connecticut, 4,988 in New Jersey, 1,305 in New York, and 53 at the three isolated infection points in West Virginia, Ohio, and Indiana. Compared with the previous year's 7,640 confirmations, which marked an increase of 17 percent over 1936, this year's total was a decrease of 15 percent.

Total infected trees recorded to date in outlying areas are as follows: Indianapolis, Ind., 85; Baltimore 2, Brunswick 3, and Cumberland 1, in Maryland; Cleveland 33, Athens 2, and Cincinnati 1, in Ohio; Wileys Ford, W. Va., 5; and Norfolk, Va., 5; or 137 in all.

EXTENSIONS OF WORK AREA

Extensions of the infected zone necessitated by the discovery of diseased elms in the 10-mile protective zone surrounding the known infected area were limited to 14 townships and cities. These were as follows: In New Jersey, West Amwell, Delaware, and Holland in Hunterdon County, Atlantic and Asbury Park in Monmouth County, and Hope Township in Warren County; in New York, Cornwall, Hamptonburg, and New Windsor in Orange County, and Fishkill, Poughkeepsie, and Hyde Park in Dutchess County; and in Connecticut, the towns of Redding and Weston in Fairfield County.

Aside from the Dutchess County extension, the infected zone now totals 5,450 square miles, divided as follows: 308 square miles in Connecticut, 3,031 in New Jersey, and 2,111 in New York. These represent increases for the year of 32 square miles in Connecticut, 88 in New Jersey, and 197 in New York. The 10-mile protective zone circumscribing the infected area comprises 707 square miles in Connecticut, 807 in New Jersey, 507 in New York, and 1,283 in Pennsylvania, a total of 3,304 square miles. This is an increase of 254 square miles over the previous year. The entire zone of field operations totals 8,754 square miles.

Revised Dutch elm disease quarantine regulations, effective November 9, 1937, added to the regulated area all towns infected on that date. One conviction for a quarantine violation resulted in a nominal fine.

ERADICATION AND SANITATION ACTIVITIES

Elms in infected areas difficult to scout and dead and dying trees in the areas of disease concentration were removed at a rapidly accelerated rate. In areas permissioned for clear-cutting, approximately 495,000 elms were removed. Also, approximately 528,000 dead and dying trees in the major infected field were removed. An additional 177,000 elms were removed in selective cutting in areas surrounding disease concentrations. There remained standing at the end of the year approximately 131,000 trees tagged for removal, as compared with 338,000 tagged for removal at the beginning of the year. The total number of trees removed in clear-cutting and sanitation work, plus over 6,000 diseased trees eradicated, was approximately 1,206,000. To June 30, 1938, a grand total of 4,530,244 trees have been removed in all activities. By far the largest number of these, 2,775,741, were removed in New Jersey. Such trees as have been removed, although of negligible economic or esthetic value, were recognized as likely centers of chronic cases of the Dutch elm disease and as breeding places for the insect carriers of the disease.

Special elm-sanitation projects were completed at three isolated sections, and at several points of disease concentration in New Jersey. At Athens, Ohio, crews engaged in clear cutting along the Little Hocking River near the location of the initial infection and in the built-up section of the city. In April removal of all worthless trees was begun. Beetle-infested wood was pruned from the remaining valuable elms within 1 mile of the diseased tree. Approximately 30,000 brush elms were removed by May 21.

All elms in the vicinity of the trees at Wileys Ford, W. Va., confirmed as infected were pruned and sampled. In Indianapolis, Ind., 92 men assigned to

winter-sanitation work completed their duties by June 1. Clear cutting was performed in several regions in New Jersey where elms were found in the summer of 1937. In two heavily infected sections in Allamuchy Township, Warren County, N. J., 13 trees confirmed as infected were located around several wood piles containing elm logs.

SOURCES OF FUNDS

Federal activities of the project during the year were financed from a regular Departmental appropriation of $460,860, supplemented by several allotments of Works Progress Administration funds totaling $2,870,686 for field operations and $34,000 for administrative expenses.

State appropriations and contributions toward the cooperative work amounted to $140,000 in New York, $41,580 in New Jersey, and $25,000 as a biennial appropriation in Connecticut. In addition $404,883 of W. P. A. funds was made available in Connecticut for a program of elm pruning and dead-tree removal, sponsored and supervised by State officials. The State of Indiana contributed the services of five experienced tree men for 3 months. The Department of Parks of the City of New York took care of the removal of all dead and dying elms on city property. Approximately $30,000 was expended by 55 municipalities in Connecticut carrying out elm-sanitation projects.

WHITE-PINE BLISTER RUST CONTROL

EXTENSIVE WHITE PINE AREAS PROTECTED IN 1937

During the field season of 1937, 75,062,268 currant and gooseberry plants (*Ribes*) were destroyed on 2,469,356 acres of control area in the protection of over 1,000,000 acres of commercially valuable white pine forest. On the area covered, 1,626,045 acres consisted of initial work and 843,311 of areas covered one or more times previously since 1918. The project required 501,773 man-days of labor.

Since 1933 this work has been conducted largely by the use of relief labor. The amount of funds allotted to blister rust control from emergency relief appropriation acts was less than half the amount granted during the previous year, and as a result the employment of relief labor dropped from some 14,000 men in 1936 to a peak employment of about 4,500 in 1937. In addition, the number of enrollees assigned to the work from the C. C. C. camps was less than in the previous year.

The details of this control work are given in table 6.

TABLE 6.—*Ribes-eradication operations for the calendar year 1937*

Region	Area covered			Effective labor [1]	Ribes destroyed
	Initial work	Rework of areas covered one or more times previously	Total initial and rework		
	Acres	*Acres*	*Acres*	*Man-days*	*Number*
Northeastern States	377,223	339,499	716,722	212,713	17,424,376
Southern Appalachian States	844,034	404,739	1,248,773	48,812	5,216,119
Lakes States	281,407	29,112	310,519	66,654	[2] 15,808,034
Western white pine area (Idaho, Montana, Washington including Mount Rainier)	85,918	35,122	121,040	116,881	26,683,975
Sugar pine area (California and Oregon)	27,051	34,839	61,890	52,670	9,526,570
Rocky Mountain States (Colorado and Wyoming)	10,412	----------	10,412	4,043	403,194
Total	1,626,045	843,311	2,469,356	501,773	75,062,268

[1] Reported as effective 8-hour man-days; the time actually worked ranged from 6 to 8 hours per day.

[2] The annual report of the Chief of the Bureau of Entomology and Plant Quarantine for 1937 (table 11, p. 34) shows 7,741,501 as the number of *Ribes* destroyed in the Lakes States in 1936. This should be corrected to read 57,741,501.

White pine areas are considered to be protected from blister rust when the *Ribes* are removed from the pine stand and for a distance of 900 feet on all sides of the stand. Occasional checking and reworking of portions of these areas are necessary at intervals of 5 to 10 or more years to maintain them free from large bushes throughout the crop rotation.

Of the acreage recorded above, about three-fourths, or 1,795,096 acres, was covered during 1937 by eradication crews paid under allotments to the Bureau of Entomology and Plant Quarantine and to the Forest Service from the Emergency Relief Appropriation Acts of 1936 and 1937. The C. C. C. enrollees covered 530,155 acres, devoting 178,870 8-hour man-days to the work. The remaining 144,105 acres were financed by numerous other cooperating agencies. Among the largest non-federal cooperators were the States of New York and Idaho, both of which provided substantial appropriations for the protection of the white pine within their borders.

STATUS OF CONTROL WORK ON DECEMBER 31, 1937

In the country as a whole there is estimated to be about 30,000,000 acres of control area, which contains between 14,000,000 and 15,000,000 acres of white pine of sufficient stocking to produce a good crop of timber at maturity. The control work is aimed at eliminating the *Ribes* on these areas so as to make them safe for the continued production of white pine. When the white pine areas are being selected, preference is given to the better sites and more valuable stands of young growth. The northern white pine of the Eastern States, the western white pine of the "Inland Empire", and the sugar pine of California and Oregon are the principal commercial species and have a high present and future commercial value. They constitute the principal white pine resources of the Nation, and the maintenance of all three as a component of our forests is highly desirable. Table 7 shows that initial protection by *Ribes* eradication has been given to 20,200,712 acres of control area. Of this area, 4,041,132 acres have been reworked. This protection work has been accomplished during the last 20 years through the destruction of 831,857,039 *Ribes*.

TABLE 7.—*Blister rust control accomplishments, 1918–37*

Region	Work accomplished 1918–37			
	Initially protected control area	Rework areas subsequent to initial protection	*Ribes* destroyed	Effective labor [1]
	Acres	*Acres*	*Number*	*Man-days*
Northeastern States	11,598,428	3,018,485	234,680,094	2,118,526
Southern Appalachian States	4,191,779	695,478	17,840,131	154,619
Lakes States	2,079,333	133,823	168,106,398	638,701
Western white pine area	1,712,403	114,281	328,785,651	1,367,382
Sugar pine area	582,331	79,065	80,970,149	296,419
Rocky Mountain States	36,438	----------	1,474,616	13,099
Total	20,200,712	4,041,132	831,857,039	4,588,746

[1] Reported as effective 8-hour man-days; the time actually worked ranged from 6 to 8 hours per day.

CONTROL WORK CARRIED ON IN COOPERATION WITH AFFECTED STATES AND FEDERAL AGENCIES

In the white pine regions of the country blister rust-control work is performed under State laws which provide the necessary legal authority for carrying out the control activities within the respective States. The work is conducted cooperatively with the affected States and with other Federal agencies responsible for the administration of public lands. The Department, through this Bureau, provides the leadership, technical supervision, and coordination needed to secure effective eradication of *Ribes* in white pine areas. The cooperating States enforce their respective State laws, determine State policies affecting the work, cooperate with counties, townships, municipalities, and individuals in the eradication of *Ribes*, and provide some of the funds and labor for control work.

The Bureau cooperates in a similar manner with other Federal agencies such as the Forest Service, National Park Service, Indian Service, and Soil Conservation Service. These agencies provide funds and labor for such *Ribes* eradication as is necessary on the public lands under their administration. The work plans are cooperatively prepared and carried out, thus assuring mutual interest and coordination of control activities.

CULTIVATED BLACK CURRANTS DESTROYED IN THE WHITE PINE REGIONS

The cultivated black currant (*Ribes nigrum*) is the most susceptible species of *Ribes* and is responsible for aiding the long-distance spread and local establishment of the disease to a far greater extent than any other species of *Ribes*. For this reason it is being eliminated throughout white pine regions, where it has small commercial value as compared with the value of the white pine. This work is therefore not confined to the control zones immediately adjoining white pine stands.

Cultivated black currants were largely eliminated some years ago in the western white pine and sugar pine regions in order to delay the spread of the disease. In the Northeastern States they have been eradicated wherever found, along with other cultivated *Ribes* in the white pine region, and in some of these States have been outlawed and completely eliminated so far as possible. In the Lakes States region they have been eradicated from large sections of the white pine areas in the last 2 years. In 1937, 26,904 plants of *Ribes nigrum* were destroyed, most of these in the Lakes States region.

WHITE PINE NURSERY STOCK PROTECTED AGAINST BLISTER RUST INFECTION

White pines are extensively used for reforestation purposes, particularly in the Eastern States and in the western white pine region. Many of the State forestry departments, as well as the Forest Service and the Soil Conservation Service of the Department, are using white pines extensively for planting purposes. To assure the planting of white pine free from blister rust, the nurseries producing this stock are protected against blister rust infection by the eradication of *Ribes*. The protection of such nurseries was carried out in 1937 in and around 121 nurseries, of which 34 were located in the Northeastern States, 36 in the southern Appalachian region, 49 in the Lakes States, and 2 in the western white pine region. These nurseries were growing 116,845,668 white pines. In protecting them 374,577 *Ribes* were destroyed in 1937 on 48,376 acres. Most of these *Ribes* were found around nurseries being worked for the first or second time. In addition to the protection of white pine stock while it is growing in the nurseries, arrangements are made with agencies engaged in reforestation work whereby the sites to be reforested with white pine are examined prior to their being planted. So far as possible sites are selected that are free of *Ribes*, or that contain so few that these can be easily eradicated.

VALUABLE PLANTED AND ORNAMENTAL PINES TREATED

Trees of high value, such as ornamental pines, pines in public parks, or pines planted on watersheds representing a considerable investment, can often be saved after they have become infected, if the disease has not progressed too far to prevent the effective removal of the diseased portions. Such work is practical only on ornamental pines or planted pines of high value and is not recommended as a control measure in native forest areas.

During 1937, 170,163 cankers were removed in this manner from 108,789 white pines in the southern Appalachian, Northeastern, and Lakes States regions. In the course of this work 1,157,133 trees were examined and 106,615 were found so badly diseased that they could not be saved, and the trees were cut down and removed.

WHITE PINE AREAS MAPPED

During the fall and winter seasons, when *Ribes* eradication cannot be effectively carried on because of the dropping of the leaves, attention is given to the location and mapping of white pine as a basis for the future application of control measures. The best of the white pine areas are selected and located on maps, and information is obtained concerning the pines and abundance of *Ribes*, and on working conditions. During 1937, 4,472,811 acres of white pine area were mapped.

DEVELOPMENT OF CONTROL PRACTICES

Experimental work was continued to develop improved control practices for the chemical treatment of certain species of western *Ribes* that are difficult to eradicate by hand methods. In this work it was found that *Ribes roezli*, *R. viscosissimum*, and *R. nevadense*, which occur in heavy concentrations of mature bushes, can be eradicated by decapitating the bushes close to the ground and treating them with Diesel oil of 29° Baumé at the rate of 0.05 gallon of oil per average large plant. For the treatment of occasional troublesome bushes of these species, the application of 2 ounces of dry ammonium thiocyanate or sodium thiocyanate to the decapitated crowns is effective. It was found that seedlings of *R. roezli* in reeradication work could be destroyed by spraying with Diesel oil at the rate of 1 gallon of oil per 100 small plants. In such work 3-year-old plants having 15 feet or more of live stem should be decapitated and the crown oiled or grubbed. Experiments were continued with *R. bracteosum* and *R. cereum* to determine chemical doses for the treatment of decapitated large bushes of these species with Diesel oil and ammonium thiocyanate. *R. cereum* occurring in rock crevices can be treated by decapitation, and treatment of the crown with Diesel oil of 29° Baumé, or a mixture of Diesel oil and crankcase oil (4 to 1), at the rate of one-third of a gallon of the mixture for the average large clump. Studies were begun on the establishment and growth rate of *Ribes* subsequent to *Ribes* eradication, to obtain data from which to determine the right interval between initial and rework, and as a basis for working out better methods for eliminating these plants.

BLISTER RUST FOUND IN MANY NEW LOCALITIES IN 1937

In the West two major developments in the spread of the disease occurred during the season, one in California and the other in western Montana. Blister rust was first found in California in 1936 at five infection points in Del Norte and Siskiyou Counties, all within 5 miles of the Oregon border. In 1937 infections on *Ribes* were found to be generally distributed in Siskiyou County, and scattered infections were found in Shasta, Trinity, and Tehama Counties. The more southern infection points were 125 miles south of the Oregon border in the Coast Range Mountains along the headwaters of the Trinity River and 120 miles south in the Sierra Nevada just below Lassen Volcanic National Park. Past experience has shown that the results obtained in blister rust scouting are usually considerably behind its actual spread. It is therefore very probable that the rust may already be present south of the known limits of infection. The large areas of wild mountainous country to be examined and the 3-year incubation of the rust on pines make it impossible to be certain of the actual limits of spread.

In the Pacific Northwest a survey was undertaken to determine the extent to which blister rust is spreading southeastward toward the whitebark pine and limber pine forest areas of the Rocky Mountain region. Since 1927, when the rust was first found in the western white pine region of Idaho, rapid and serious intensification of the disease has been occurring on unprotected areas, and it is now evident that many stands of young white pine probably will be a total loss before the *Ribes* can be eradicated. While the disease has increased in the western white pine region, it has also spread to the surrounding country in which the susceptible whitebark pine and limber pine grow at the higher altitudes. Most of the acreage supporting these species is south and east of the western white pine stands, with extensive areas in southwestern Montana and in Wyoming and Colorado. The rust survey was conducted during September 1937, and infection on *Ribes* was found at 16 points in the Bitterroot, Beaverhead, Deer Lodge, and Gallatin National Forests. The discovery of the rust on the Beaverhead National Forest marked the first extension of the known range of the disease in the West to the east of the Continental Divide. The most eastern location was found on the Gallatin National Forest within 19 miles of the northwestern corner of Yellowstone National Park and 26 miles of the Wyoming line. The rapidity with which the rust is likely to spread in the whitebark pine and limber pine regions cannot be predicted. Both these species are highly susceptible to the rust and are associated with susceptible *Ribes*.

In the north-central region the rust was found for the first time on white pine in Antrim County, Mich., the Bad River Indian Reservation in Minnesota, and Monroe, Sauk, LaCrosse, Brown, Trempealeau, Florence, Kewaunee, and Marinette Counties, Wis. On *Ribes* the disease was found for the first time in Palo Alto County, Iowa; McHenry, Winnebago, Boone, Lake, and Kane Counties,

Ill.; Clinton, Washtenaw, Arenac, Gratiot, Wayne, Livingston, Agemaw, and Shiawassee Counties, Mich.; Fairfield and Lorain Counties, Ohio; and Trempealeau, Kenosha, Racine, Milwaukee, Walworth, and Waukesha Counties, Wis. Practically all the infection on *Ribes* in counties in Illinois and Wisconsin resulted from the spread of the rust on cultivated black currants.

In the northeastern region blister rust infection is general, the amount of the disease varying considerably in different localities. There are many local areas where infection on pine ranges from 10 to nearly 100 percent of the trees in unprotected areas. In well-protected areas pine infection has practically ceased, following the eradication of *Ribes*.

In the southern Appalachian region, extending from Maryland to Georgia, blister rust was found for the first time on *Ribes* in Delaware, where it was discovered in northern Newcastle County. It was also picked up for the first time on *Ribes* in Harford, Baltimore, and Carroll Counties, Md., and in Alleghany County, Va. The disease is now present in most of the counties in the white pine belt extending from Maryland southward along the Appalachian Mountains to central Virginia and West Virginia.

MODIFICATION OF WHITE-PINE BLISTER RUST QUARANTINE REGULATIONS

All restrictions on the interstate movement of five-leaved pines—except to points in two pine-growing regions in which the blister rust has not been found, one in the West and the other in the Southeast—were lifted in a modification of the white-pine blister rust quarantine regulations which became effective July 1, 1938.

An embargo is placed on the interstate movement of five-leaved pines into the western States of Arizona, Colorado, Nevada, New Mexico, Utah, Wyoming, and part of California, and into the Southeastern States of Georgia, Kentucky, North Carolina, South Carolina, and Tennessee, from States other than these 11 entire States and from 10 northern California counties.

The currant and gooseberry shipping regulations also are revised. The extensive Federal-State control work throughout the infected States is continued; and in order to protect accomplishments and to maintain sanitation zones around the valuable pine stands the control-area permit requirement is extended to apply to shipments to 23 States. The requirements as to dormancy, defoliation, or dipping of currant and gooseberry plants are continued in the case of shipments to the 12 pine-growing States to which pine shipments are prohibited. The embargo as to shipments of European black currants throughout the United States except into 12 Central States is continued unchanged.

CEREAL AND FORAGE INSECT INVESTIGATIONS

WHITE-FRINGED BEETLE

A new and serious insect enemy of field crops, the white-fringed beetle (*Naupactus leucoloma* Boh.), was discovered in August 1936 near Svea, Okaloosa County, in western Florida. It was subsequently found in Walton County, Fla., and in the neighboring county of Covington, in southern Alabama. Surveys immediately instituted resulted in the finding of this pest in New Orleans, La., and in the vicinity of Laurel, Miss.

This insect is native to South America, where it is known from Argentina, Chile, and Uruguay. Preliminary studies conducted in southern Alabama have shown that it has formidable characteristics. All the beetles are of the female sex and potentially able to reproduce at a very high rate. A single beetle may lay as many as a thousand eggs in the course of a few weeks. These are deposited on or in the soil or are attached to sticks, stones, or vegetation and, when subjected to dry conditions, live for many months, and hatch immediately when supplied with moisture. The newly hatched grubs are capable of living for weeks without food and can feed on the roots of almost every kind of herbaceous and many kinds of woody plants. The grubs attack practically all varieties of field crops, but are especially fond of cotton, peanut, cowpea, sweetpotato, corn, and velvetbean. They have, however, already been found feeding on 124 species of plants belonging to 41 families. The full-grown grubs have lived as long as 100 days when fully submerged in water. As they feed on the roots and underground stems of plants, embedding themselves in their tissues, they are very likely to be trans-

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ported long distances through the shipment of nursery stock, either on the plants or in the soil surrounding the roots. As this insect is believed to have been present for some years, it is probable that spread by such means has already occurred. Fortunately the adult beetles are wingless and can spread unassisted only by crawling over the surface of the soil. Like the grubs, however, the beetles feed on a variety of plants, both cultivated and wild. Among their favorite cultivated host plants are cotton, peanut, velvetbean, and blackberry. As many as 80,000 beetles have been collected from one-half of an acre of cotton in 4 hours' time.

Active investigation of the biology and methods of control of the white-fringed beetle are under way. It has recently been found that a 25-percent emulsion of ethylene dichloride applied at the rate of 1 gallon per square yard killed all the grubs in the soil. Many kinds of insecticides are being tried against the adult beetle, as well as various mechanical methods of control.

GRASSHOPPERS

As stated in the last annual report, 20 States were furnished bait materials during the campaign for the control of grasshoppers. The formula used in estimating the number of tons of bait furnished was mill-run bran 500 pounds, sawdust 1,500 pounds, and sodium arsenite 10 gallons. The total amount of bait furnished the cooperating States was 75,439.37 tons. The total expenditure for this and its transportation was $1,125,600. This statement of costs is based on the expenditures from Federal funds and special additional expenditures by State and local agencies in carrying out the cooperative control work. It does not, however, include salaries of county agents and regular State employees who participated in the organization work, or the labor of farmers who distributed the bait.

The estimated value of the crops saved by these operations was $102,288,177, or a return of $51.78 for every dollar of expenditure. In addition, the control work made possible the harvesting of crops that would otherwise have been destroyed. In view of the vast areas infested, little effort could be made to do more than protect most of the cultivated crops. An offensive warfare against the hordes of grasshoppers hatching on range lands, public domain, or other extensive uncultivated areas was impossible. Owing chiefly to this fact, invasions of grasshoppers from such sources are estimated to have destroyed crops to the value of $65,827,215. The work of the season, however, gave proof that effective control can be obtained by baiting in accord with recommended methods; that, when applied as recommended, control measures can be used without injury to man, livestock, or wildlife; that best results are obtained when the work is done on a community basis; that efficient organization is necessary to obtain the best results; that provision should be made for control work on highways, right-of-ways, and uncultivated areas adjacent to crops; that plans should be made and announced early in the crop year and before grasshoppers have hatched; and that, where practicable, methods of control other than baiting should be used as auxiliary. The usual grasshopper survey, conducted in the fall of 1937, developed the fact that in addition to the 20 States involved in the campaign of 1937, four others, Idaho, Nevada, Oregon, and Washington, contained serious infestations and would have to be included in any plans for control in 1938. It was also shown that, in spite of the successful control campaign for the protection of crops waged in 1937, heavy intensifications of infestation had occurred in the Great Plains and Northern Rocky Mountain States. Estimates based on this survey indicated that, barring general weather changes unfavorable to hatching in the spring of 1938, the bait requirements for an adequate campaign would be not less than 180,000 tons, or practically twice those of 1937.

The results of the research work on grasshoppers during the previous 2 years proved most valuable in 1937 when, owing to an acute shortage in wheat bran, they permitted the adoption of a formula which had been tested previously and that substituted sawdust for an additional 25 percent of the bran previously used. It is estimated that by the use of this formula a saving of approximately $5 per ton of bait was made without apparent loss in effectiveness.

A revised edition of Farmers' Bulletin 1691, issued in April 1938, contained the most recent information regarding improved formulas for grasshopper baits, together with timely information on efficient methods of distribution.

Studies of the important species of range-infesting grasshoppers conducted in Montana demonstrated that, where these grasshoppers were present in numbers of 20 per square yard, they had destroyed no less than 67 percent of the range vegetation in 2 months' time. One of these, the long-winged grasshopper (*Dissosteira longipennis* (Thos.)), was the chief species injurious to crops in eastern Colorado, northeastern New Mexico, and the Panhandles of Texas and Oklahoma for the past two seasons, where it caused crop losses over wide areas. This emphasizes the importance of the present studies of range grasshoppers. Owing to the low intrinsic value of most of the lands concerned in this problem, poisoning for grasshopper control on them by present methods is not practical. It is hoped, however, that through a comprehensive study of the entire problem a method of handling such lands can be worked out which will result in eliminating or greatly diminishing outbreaks originating on such areas.

INSECTS ATTACKING CORN

Further improvement and simplification of methods of protecting sweet corn from the attacks of the corn earworm resulted from studies of the year. These results furnished alternative methods of protection, both of which promise satisfactory control for the earworm in early-market sweet corn and also for sweet corn grown in the home garden. One of these consists of the insertion in the ear tip, after pollination has occurred, of a machine-made tablet of hexachlorethane containing 0.5 gram, following which a simple wire clip is slipped over the silks and self-fastened. The gas generated within the ear kills any worms present and remains long enough to protect it from further invasion without injury to its flavor or otherwise. The alternative method is even more simple, consisting of the injection into the silks of a few drops of mineral oil of medical quality, and the subsequent placing of the wire clip. Extensive field tests are now being made of these methods, and it is expected that full directions for their use can be published at the close of the season of 1938. Applications for public-service patents on these inventions have been made to render them fully available for free public use.

During the protracted and extensive droughts that began in 1930, throughout the region inhabited by that strain of the European corn borer which has usually exhibited only a single generation annually, there was an apparent cessation in the rapid western spread of the insect which was an alarming feature of the period 1921–30. In 1936 significant increases in the rate of infestation were observed in southeastern Michigan and northwestern Ohio but a decrease in infestation was noted in southwestern Ohio counties. In 1937 there was not only a marked further increase in rate of infestation in southeastern Michigan and northwestern Ohio but also a distinct increase in the southwestern counties of Ohio and an extension of severe infestation into northeastern Indiana. In early sweet corn in Lucas County, Ohio, the infestation in 1937 reached an average of eight borers per plant, and reports received in the spring and early summer of 1938 revealed that there has occurred an alarming further increase in this area.

Serious injury to the corn crop by the corn borer in Indiana, Michigan, and Ohio is indicated for the near future unless vigorous control measures for the pest are at once renewed on a community basis.

In the region where the European corn borer produces two generations annually, extending from central New England along the coast southward to the Virginia Capes, similar intensification of infestation was recorded. Eastern Massachusetts, central Connecticut, southern New Jersey and Delaware, and the Eastern Shore of Maryland and Virginia are most heavily involved.

Progress in the development of strains and varieties of field corn exhibiting resistance to the European corn borer demonstrated that one of the crosses showing inherent resistance possesses a quality that serves to reduce the numbers of borers surviving on it, and that those borers which do survive become stunted and lack vitality to survive winter conditions. There is increasing hope that commercial varieties eventually will be produced which will assist materially in the control of this pest.

Methods were perfected during the year which will permit satisfactory control of the European corn borer on early-market sweet corn, where the margin of profit is sufficient to allow reasonable expenditure for control purposes. This consists of the application of sprays and dusts containing nicotine tannate, by the use of which it is possible to produce yields of sweet corn having 90 percent of the ears free from borers. This method is also applicable to sweet corn grown in the home garden.

INSECTS ATTACKING SMALL GRAINS

At the beginning of the growing season of 1937 the hessian fly was not numerous, and infestations were light or scattered in character. During the fall weather conditions proved more favorable for the insect, with the result that infestation increased rapidly in some localities.

The results of tests of 16 varieties of spring wheat with a view to the selection of those resistant to the hessian fly supported previous tests in that the varieties and selections previously exhibiting a high degree of resistance again showed much lower degrees of infestation than did those in the check plots. In similar tests of 51 selections of hybrid spring wheats in which deposition of eggs by the fly was very heavy, a number of these selections showed real promise of being materially fly resistant. In extensive tests of hybrids and selections conducted in cooperation with the Bureau of Plant Industry at La Fayette, Ind., out of 574 selections tested 91 showed conclusive evidence of resistance in the presence of heavy infestation, and have been reserved for further breeding work.

An experiment was begun in the fall of 1936 with hessian flies from California and Indiana, respectively, to determine the reactions of these strains of the insect toward certain differential varieties of wheat. The results thus far obtained indicate strongly that these flies represent different biological strains of the insect, since they reacted distinctly toward the test plants.

An extensive outbreak of the true armyworm occurred in the spring of 1937 in western Mississippi, southeastern Arkansas, and eastern Oklahoma. This afforded unusual opportunity for the comparison of control methods. In Mississippi more than 75,000 acres of winter oats was infested and much of this was dusted by the growers with calcium arsenate applied by airplane. Satisfactory results were obtained in this way where good coverage occurred with heavy doses of from 18 to 30 pounds of the insecticide per acre. Comparative large-scale tests made by Bureau investigators with the use of standard poisoned-bran bait showed that this method of control was, in general, considerably superior to dusting. Field studies of the degree of chinch bug infestation, made early in 1938, indicated that there had been a further recession in the general outbreak of the chinch bug that began in 1932 and reached its peak in 1934. The cool wet weather of the spring of 1938 throughout the Corn Belt apparently served further to repress the insect, and it is now apparent that the general outbreak has definitely waned.

INSECTS ATTACKING FORAGE CROPS

In experiments to determine the liability of transportation of the alfalfa weevil through commerce in hay, it was shown that a very small infestation of the weevil survived for a period of 8 months in baled native (Utah) grass hay. In alfalfa hay grown in a sparsely infested area in Idaho, and baled from haystacks in winter, small numbers of weevils survived for as long as 9 months. Weevils lived for nearly 7 months in experimentally baled hay stored under outdoor conditions, as contrasted with 3 to 4 months indoors as shown by the results of 1937. The female weevils surviving in such baled hay laid fertile eggs after being supplied with fresh food and being placed in a warm room.

A survey during June 1938 developed the fact that the alfalfa weevil had appeared in 12 new counties in 5 different States, viz, Douglas County, Oreg.; Big Horn County, Mont.; Big Horn, Hot Springs, Laramie, Park, and Washakie Counties, Wyo.; Banner and Kimball Counties, Nebr.; and Pitkin, San Miguel, and Weld Counties, Colo. The infestation in Weld County is of special interest, as it marks the appearance for the first time of the alfalfa weevil on the eastern slope of the Continental Divide in Colorado. During the year an extensive manuscript on the bionomics of the alfalfa weevil, which reviews in a comprehensive way the results of all the work with this pest to date, is being prepared for publication.

Experiments in the control of the potato leafhopper on peanuts confirmed the results obtained the year before, thus demonstrating that the application of dusts composed of copper and sulphur resulted in increased yields of from 30 to 60 percent of field-cured peanuts. The results of such work were published cooperatively as Bulletin 316 of the Virginia Agricultural Experiment Station.

INSECTS ATTACKING SUGARCANE

A survey made to determine the extent of injury by the sugarcane borer to the sugar crop of 1937 showed that 16.5 percent of the joints were bored as

compared with 8.7 percent in 1936. From nearly complete sugar-production figures it is estimated that through the work of this pest the growers lost sugar to the value of $3,583,000.

Experiments made with a view to breeding varieties of sugarcane that may exhibit resistance to attacks of the borer indicated that a New Guinea variety, introduced by the Department in recent years, may be of value as a parent cane in breeding for resistance to the borer.

Recovery was made of a tachinid parasite of the sugarcane borer introduced from Cuba in 1936 at Grand Isle, La. It was found that the rate of parasitization at that time was 11 percent. Whether or not this record indicates permanent establishment can be determined only by subsequent observation.

Recent studies with cryolite applied as a dust for the control of the sugarcane borer gave considerable encouragement. It was found that the untreated plots contained from 8 to 10 times as many borers as those treated with the insecticide.

INSECTS ATTACKING STORED GRAINS

Many millers depend on chloropicrin, or tear gas, for the periodic fumigation of individual machinery units. Tests of this gas under actual commercial conditions, conducted by Bureau experts, have shown that doses up to 1½ pounds per unit killed all adults of the flour beetle but failed to kill most of its eggs. As a substitute for this it was determined that a mixture of ethylene dichloride 75 percent and carbon tetrachloride 25 percent gave equally good kills of adults and larvae and far better kills of the eggs. It is much less disagreeable to use and costs only one-eighth as much as chloropicrin.

The preservation from the attacks of insects of rough rice in storage has long been a serious problem. Most of this product is stored in loosely constructed warehouses and mills throughout the Gulf or Southern States. The rice becomes somewhat infested with insects before harvest; and this infestation, when carried into storage, increases rapidly under the prevailing mild and moist climatic conditions, frequently causing an immense aggregate loss to the growers and processors of the grain. Observations were made during the year on the fumigation, under atmospheric pressure, of 2,500,000 pounds of rough rice stored in a tightly constructed warehouse having a capacity of 100,000 cubic feet.

The rice was fumigated with liquid hydrocyanic acid at a dose of 1¾ pounds per 1,000 cubic feet of space, applied at a temperature of 80° F. for a period of 72 hours. This resulted in a complete kill of all stages of the insects; thus indicating that, when stored in suitable buildings, the fumigation of rough rice is perfectly feasible.

Further experiments with borax as an insecticide for application to rough stored rice developed the fact that, although it killed most of the insects, the boron was adsorbed by the grain in sufficient quantities to render its use undesirable.

A new and valuable method of fumigation for clean rice was discovered. The atmospheric fumigation of stored rice with hydrocyanic acid gas has not heretofore proved successful because the outer portions of the mass absorb much of the gas. A relatively expensive method of fumigation under vacuum has therefore been used to control the insects in this commodity. It has now been found that by spraying the grain stream with liquid hydrocyanic acid as it moves into a closed tank or container, so that the fumigant reaches all the grain, all insect life in it is killed. This discovery should result in large savings to millers and processors of rice throughout the South.

Loss from insect attack on cattle feed held in storage is often heavy. Studies of a practical method of fumigating such feeds in a vault under atmospheric pressure have demonstrated that an application of 7½ ounces of liquid hydrocyanic acid per ton of feed killed all insect life in sacked feed when this was left undisturbed for 48 hours after fumigation was finished.

A study, in representative mills of the Middle West, of the methods used to re-dress flour revealed that there was lack of uniformity in the methods used, and that a few mills were using systems capable of removing insect infestations from finished flour. Contamination was found to originate from blending of returned flours, blending in of purchased or stored clear flours, the use of reels instead of sifters in re-dressing flours, and the location of conveyors, chlorine agitators, and elevators between the re-dress machinery and the packer bins. To obviate these faults, a model system of handling flour was outlined and published during the year.

WHITE-FRINGED BEETLE CONTROL

When the white-fringed beetle was discovered recently in the Gulf States it was recognized as a possibly serious pest. Parthenogenetic in its development, prolific in reproduction, feeding on a wide variety of plants, diverse in methods of distribution, and not vulnerable to attack at any point in its life history, this insect presented a serious problem in control when this project was started in July 1937.

Though the infested area is probably not delimited as yet, the white-fringed beetle is known to occur in the counties of Escambia, Okaloosa, and Walton in western Florida; in the counties of Covington and Geneva in Alabama (though in the first few days of July 1938 it was found in Conecuh, Mobile, and Monroe Counties, Ala.); in the counties of Covington, Harrison, Jackson, Jones, and Stone in Mississippi; and in three parishes in the immediate vicinity of New Orleans, La. To determine the infested areas was an active part of the program during the year. A five-phase survey plan was developed in the current season involving regular personnel and volunteers. Work by the regular personnel consisted of (1) intensive inspection of known areas to determine outer limits, (2) extensive surveys in infested States to find outlying infestations, (3) spot inspections in neighboring States and more remote areas of infested States for chance discovery of possible incipient infestations, and (4) inspections by State pest-control officers of planting points or destinations of shipments of nursery stock, made during the past 3 years, from nurseries now known to be infested. These shipments went to 44 States and the District of Columbia. Work by volunteers contemplated the cooperation of Boy Scouts, Future Farmers of America, county agricultural agents, home demonstration agents, and garden clubs. Splendid cooperation was given. A taxonomic unit was established at Gulfport for determination of specimens submitted by survey personnel.

Large-scale experiments in control methods were conducted in the original known infested areas. The use of calcium arsenate dust on foliage kills enormous numbers of beetles. Dust-mulch furrows and post-hole traps show promise under certain conditions. Clean cultivation, burning of plants, and weed-killing sprays on foliage contribute to starvation. Precipitation presents a difficult factor in the use of some of these methods.

The shipping of many products, such as lumber, nursery stock, cotton, cottonseed, soil, etc., from the infested area presents serious difficulties on the control of spread of the pest. Efforts are being made to determine the practicability of fumigation of products to permit movement from the area.

Full cooperation is being afforded by the infested States toward inspection, control, and prevention of spread. State quarantines and local ordinances are in force regulating the production and movement of products liable to encourage or distribute the pest. Local W. P. A. projects are assisting materially in control operations.

MORMON CRICKET CONTROL

Federal funds were allotted for the control of Mormon crickets from appropriations for the control of incipient and emergency outbreaks of insect pests and plant diseases. The control program was designed on a crop-protection basis, in which Federal, State, and local governmental agencies could cooperate in furnishing supervision, materials, transportation, and labor.

Field headquarters were established at Salt Lake City, Utah, and understandings were developed with States, counties, and communities in which infestation occurred as to the basis of cooperation and the responsibilities of all interested agencies. Federal funds were to be used for supervision, the employment of labor, the purchase of light dusting machines when necessary, and the furnishing of dusting materials and oil as an offset to locally furnished equipment or labor. Cooperating States were to furnish additional technical and supervisory personnel, transportation for labor, materials, and equipment, and mixing and storage plants, and additional dust materials and oil. Over 150 power-dusting machines were purchased by communities and individuals.

The peak of control operations was reached late in June, when over 950 laborers were employed by the Bureau in infested areas. Work was conducted in the States of Colorado, Idaho, Montana, Nevada, Oregon, South Dakota, Utah, Washington, and Wyoming.

Barriers of various types were used to stop the crickets in their march from breeding grounds in mountainous or waste areas to agricultural land. Metal

strips 10 inches high, totaling 185 miles in length, were repeatedly erected, and traps were constructed at intervals along this barrier to catch the crickets. Fifty-six miles of earth barrier were erected, and oil films were maintained on 338 miles of available streams and irrigation ditches to kill crickets attempting to cross.

When crickets were "bunched" or were on the march, sodium arsenite dust was applied on them with hand or power dust guns. By the close of the year more than 150,000 acres had been dusted in the control campaign of 1938, and despite heavy migrations from breeding grounds to agricultural lands exceptionally fine control was effected with these methods. On nonagricultural land in some areas trees, shrubs, and small native plants were severely injured. Cattle were reported to be leaving infested range land because the range was denuded by crickets.

EUROPEAN CORN BORER INSPECTION AND CERTIFICATION

Federal inspection and certification continued with the personnel necessary to fulfill State requirements prescribing that host material likely to spread the European corn borer must bear Federal certification before entry into Arizona, California, Colorado, Georgia, Louisiana, Nevada, Oregon, Texas, and Utah. The major portion of the work was performed in conjunction with inspection activities under the Japanese beetle and gypsy moth quarantine regulations.

With the increase in corn borer population in several extensive dahlia-growing sections of southern New Jersey, more detailed inspection of individual lots of dahlia tubers was required beyond the regular field scouting to determine presence or absence of the borer in dahlia plantings. Lowered production and poorer-quality tubers were in some instances attributed to heavy borer invasion.

Inspectors issued 21,460 certificates authorizing the movement of plant material having an estimated value of $199,000. The volume of work closely paralleled that of the previous year.

BLACK STEM RUST QUARANTINE ENFORCEMENT

An important change in the black stem rust quarantine, effective September 1, 1937, was the addition of the States of Missouri, Pennsylvania, Virginia, and West Virginia to those previously designated as protected. This action was taken at the request of the four States concerned and in consideration of the rather extensive eradication of rust-spreading barberries carried on in these States. Nurserymen in various parts of the United States may be supplied with Federal permits authorizing the shipment of immune species of barberries and mahonias into any one of the 17 protected States. Such permits are issued only for nurseries where, as determined by inspection, none other than rust-resistant species are grown. During the year such permits were issued to 34 nurserymen and 1 dealer. The Japanese barberry (*Berberis thunbergii*), an immune species, and its horticultural varieties, are exempted from the quarantine requirements. Twenty-five other species of barberries have been determined as eligible for shipment to the protected States under permit.

BARBERRY ERADICATION

The number of rust-spreading barberry bushes in Colorado, Illinois, Indiana, Iowa, Michigan, Minnesota, Montana, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin, and Wyoming has been greatly reduced since 1933, when the first of several allotments of funds appropriated for the relief of the unemployed became available to the Bureau for the expansion of field operations in connection with this and similar projects. There are more than 100 species of barberry in the United States that are susceptible to attack by the fungus causing stem rust of wheat, oats, barley, rye, and many native grasses.

During this period an intensive survey has been made of all uncultivated lands in more than 350 counties, and all barberry bushes found have been destroyed. Known areas of infestation have been brought under control in an additional 240 counties. As the eradication program progresses, all infested areas found are carefully mapped, affected properties recorded, and counties in which the work has been completed are classified by townships with respect to future survey needs. Of the 980 counties making up the 13 States com-

prising the original control area, progress maps for 946, showing the present status of control operations, have been completed, and copies are now on file in the Washington office. About one-half of these have been prepared on the basis of results of control work conducted prior to the time that emergency funds became available. When another more intensive survey is completed in these counties, revised progress maps will be prepared.

In Montana, Wyoming, North Dakota, South Dakota, eastern Colorado, and western Nebraska known infestations are now under control, and it is expected that there will be little need for the extensive use of labor after the close of the next field season. Results of control work conducted in these States during the past 3 years indicate that the remaining bushes are widely scattered, and plans for a maintenance program are now being considered which will provide for reinspections in areas where bushes have been found, the location of those missed during previous surveys, and continuation of an annual rust survey to determine localities in which prevalence of stem rust indicates the presence of bushes.

In eastern Nebraska, southwestern Colorado, Iowa, Minnesota, and States east of the Mississippi River the program is not so far advanced, and there are many known areas of infestation needing attention just as soon as available funds will permit.

In addition to work completed in the States listed, a vigorous program has been continued in the more important grain-growing counties in Missouri, Pennsylvania, Virginia, and West Virginia, where extensive eradication programs were first undertaken in 1935. In Pennsylvania and the Virginias the topography, weather conditions, and other factors are such that stem rust may be controlled locally by removing barberry bushes from uncultivated lands in and immediately adjacent to important grain-growing communities. In these States farmers are taking an active part in the eradication of bushes on and near their own properties.

Table 8 summarizes the progress in barberry eradication during the year. In analyzing the tabular information, it should be kept in mind that figures for Virginia, West Virginia, and Colorado are hardly comparable with those of other States in the control area, as much of the work conducted in these States during the year has been in areas where native species of barberry are prevalent. *Berberis fendleri* in Colorado and *B. canadensis* in the Virginias grow in patches, often several rods in diameter, which accounts for the relatively large numbers of bushes destroyed in these States.

TABLE 8.—*Progress of barberry eradication during the fiscal year 1938*

State	Territory surveyed	Properties cleared	Bushes destroyed	Salt used
	Square miles	*Number*	*Number*	*Tons*
Colorado	564	114	1,948,351	64.94
Illinois	3,890	200	7,420	6.07
Indiana	3,325	61	342	.86
Iowa	5,503	381	21,707	37.11
Michigan	2,634	437	231,615	104.17
Minnesota	7,749	220	2,266	23.20
Montana	1,100	10	866	.35
Nebraska	3,700	56	410	1.68
North Dakota	1,700	8	641	.92
Ohio	3,250	256	48,575	56.68
South Dakota	1,702	13	25	.06
Wisconsin	1,120	260	86,962	93.41
Wyoming	280	3	3	0
Total	36,517	2,019	2,349,183	389.45
Missouri	1,875	49	493	.55
Pennsylvania	1,388	1,095	4,160,788	548.34
Virginia	113	374	9,666,586	582.62
West Virginia	147	207	15,975,812	975.79
Total	3,523	1,725	29,803,679	2,107.30
Grand total	40,040	3,744	32,152,862	2,496.75

DEVELOPMENT OF STEM RUST IN 1937

Extensive observations were made during the year to determine the source of inoculum causing the widespread stem rust epidemic in 1937. From a comparatively limited number of urediospores overwintering in Texas, and possibly some migration of spores from southern Mexico, stem rust multiplied rapidly early in May in northern Texas, where grain crops were heavy and succulent. Under wind and moisture conditions favorable to rust development, the epidemic spread northward and eastward as the season advanced. In the winter-wheat area there were heavy losses in certain sections of northern Texas and part of northeastern Oklahoma, eastern Kansas, Missouri, central Illinois, and south-central and southwestern Ohio. Farther north, in the spring-wheat region, the epidemic reached its greatest intensity in northeastern South Dakota, southeastern North Dakota, and west-central Minnesota.

During the year 1,117 aecial and uredial collections obtained in the United States and northern Mexico were identified. From those collected in the United States 22 different physiologic races of the stem rust fungus were isolated and 13 were identified from collections made in Mexico. Race 56 was by far the most prevalent in the United States. It comprised 55.7 percent of all isolates. Race 38, the next most prevalent, comprised 8.7 percent of all identifications. Races 11 and 49 were about as common as 38. Others identified included races 17, 36, 19, 34, 57, and 146. Race 34, which was one of the most prevalent several years ago, constituted only 1.1 percent of the isolates made this year. Race 57 had been found only once previously, and that was in 1929. Race 146, found for the first time in 1936, was again identified from collections made this year.

On the basis of complete rust surveys, such as those made in recent years, and prompt identification of prevalent forms, it is possible to determine several weeks in advance the varieties of grain that are likely to be severely attacked by stem rust, allowing, of course, for the influence of weather conditions.

Marquis and Ceres, two varieties of hard red spring wheat, are highly susceptible to race 56. Thatcher, a new spring wheat variety, is highly resistant to race 56.

SPECIES OF BARBERRY SUSCEPTIBLE TO ATTACK BY THE STEM RUST FUNGUS

Studies to determine the susceptibility of unclassified species of barberry were conducted under controlled conditions at St. Paul, Minn., and under field conditions at the Foreign Plant Introduction Garden, Bell, Md.

An exceptionally good test of more than 150 species of barberry was obtained this year at Bell, Md. Conditions were such that an abundance of infection resulted from inoculations and, with the follow-up work to be done under greenhouse conditions, many species heretofore considered questionable will be definitely classified, by the close of this field season, as either resistant or susceptible.

The results of susceptibility tests conducted during the last 4 years have established 102 species as definitely susceptible when inoculated under outdoor conditions, and 31 species as sufficiently resistant or immune to be considered safe for propagation or distribution within the protected States. Species that have been determined as definitely resistant or definitely susceptible will be removed from the test plots before inoculations are made next year. Type specimens of each species collected from anywhere in the United States will be retained in a barberry garden for observation in connection with taxonomic studies.

THIRTY-THREE NURSERYMEN GRANTED PERMITS TO SHIP BERBERIS INTERSTATE

During the summer and fall of 1937, 46 eastern and midwestern nurserymen planning interstate shipment of immune species of *Berberis* and *Mahonia* (other than *Berberis thunbergii*) made application for the required inspection of their properties. Rust-susceptible barberry plants to the number of 2,870 were destroyed during the course of the inspection work, which involved more than 10,500 acres of nursery stock. Thirty-three nurserymen fulfilled the requirements of quarantine No. 38 (revised) and were granted interstate shipping permits by the Division of Domestic Plant Quarantines. Nine failed to qualify, and no action was taken in the case of four pending further clean-up

work. During the year the Bureau received for identification, through the mail, more than 150 specimens of *Berberis* from various parts of the country.

A recent survey of nursery catalogs on file in the Department library indicates that fewer than 40 nurserymen throughout the United States are now advertising susceptible species of barberry for sale.

Accurate identification of barberries encountered by Federal quarantine inspectors, State nursery inspectors, and eradication supervisors is essential in connection with the proper administration of quarantine No. 38 (revised), the object of which is to prevent, through education and regulation, the interstate movement of susceptible species of barberry into or between States comprising the protected area.

CHEMICAL ERADICATION OF NATIVE SPECIES OF BARBERRY

As a result of tests conducted on 1-square-rod plots infested with *Berberis fendleri* and *B. canadensis* in Colorado and West Virginia, respectively, it was found that 85 to 100 pounds of evaporated salt dissolved in water and applied as a spray and soil drench was sufficient to give a 99 to 100 percent kill. During certain months of the year, and under certain soil conditions, quantities ranging from 60 to 75 pounds per square rod proved sufficient. In actual field practice, however, at least 85 pounds per square rod is needed to insure complete eradication, and 90 to 100 pounds is used in loose, sandy soil and on hillsides where the results of the treatment may be affected by rapid leaching of the salt.

EDUCATIONAL WORK ACCOMPANYING CONTROL OPERATIONS

Information concerning barberry eradication released to the public during 1937 was restricted largely to brief illustrated circulars, news items in local papers, circular letters, and frequent reports on the occurrence and spread of rust during the critical stage in the development of grain crops.

The purpose of the educational work is to advise property owners with respect to the nature of the stem rust disease and the recommended control measures, to stimulate property owners to keep their farms free of rust-susceptible barberry bushes once the initial eradication work has been completed, and to encourage reports of badly rusted grain fields or areas known to be infested with barberry bushes as a guide to communities in which survey work is urgently needed.

Statements based on observations made by Bureau representatives relative to the development and spread of stem rust were submitted to the Department Press Service weekly during the growing season. The first of these related to the first appearance of stem rust in grain fields in northern Mexico and Texas. Later reports dealt with the development and northward spread of rust through the winter wheat belt and into the spring wheat States.

TRUCK CROP AND GARDEN INSECT INVESTIGATIONS

WIREWORMS

The investigations of wireworms occurring in irrigated lands were continued in eastern Washington, southern Idaho, and southern California. These investigations consisted principally of studies of the utility of crude naphthalene as a practical control for wireworms, the further testing of dichloroethyl ether under field and laboratory conditions, studies of the effect of crop rotation on wireworm populations, and studies of the effect of time of planting of potatoes on wireworm populations and the habits of wireworms, both larvae and adults, which may have a direct bearing on control measures. The field experiments with crude naphthalene were carried out by applying different quantities of the material at different periods of the season. These experiments show that it is practical to fumigate with naphthalene as early as the latter half of May in the eastern Washington area. At the present time it would appear that the greatest use of crude naphthalene in that area is in the reduction of heavy infestations to the point where the more susceptible crops can be grown with a high degree of freedom from damage. It is evident that the type of soil has a very definite bearing on the penetration of the naphthalene vapor and the resultant wireworm kill.

A typical example of the effect of alfalfa on wireworm populations is shown in a field that had been in alfalfa for 5 years. Prior to the planting of alfalfa

the population in this field averaged eight per square foot. During the spring of 1937 one-half of the field was planted to potatoes and the other half to onions. An examination of the onion and potato fields showed that in the potato field there was less than one wireworm per square foot and less than 4-percent damage to the potato tubers, and that in the onion field the wireworm population averaged a little more than one wireworm per square foot and the damage was approximately 11 percent to the onion crop.

The tests with dichloroethyl ether in California disclosed that aqueous solutions of this material diluted at the rates of 6, 9, and 12 cubic centimeters per gallon gave a mortality ranging from 67 to 100 percent of the wireworms. These solutions were applied to tomato, corn, cabbage, and potato plants. No detectable plant injury resulted to any of these crops except in instances where the 12 cubic-centimeter dilution was applied at a dosage of 1 gallon per plant.

BEAN AND PEA INSECTS

MEXICAN BEAN BEETLE

Insecticidal tests[1] for the control of the Mexican bean beetle were conducted in Ohio, Virginia, and Colorado.

Field experiments in Ohio and Virginia on beans grown for the green-bean market or for canning showed conclusively that this pest can be satisfactorily controlled by the use of sprays or dust mixtures containing rotenone derived from derris, cube, timbo, or devil's shoestring. Cryolite sprays gave satisfactory control in most instances. Copper cyanide gave a fair degree of control of the insects, but moderate plant injury resulted. Fairly satisfactory results were obtained with the new insecticide sulphur nitride, particularly when it was milled in such a manner as to produce fine particles. Experiments with mechanical equipment demonstrated that the use of hoods attached to power dusters permitted a reduction in dosage of the insecticide without causing any reduction in the degree of control.

In Colorado the results from tests on irrigated beans grown for the dry-bean market demonstrated that sprays containing derris and cube gave better results than any other materials tested, and that cryolite sprays gave the next best results. Also, that sprays containing zinc arsenite, commonly used by the growers in that district, were third in rank according to the degree of control of the Mexican bean beetle obtained with these insecticides.

PEA WEEVIL

Biological and control investigations on the pea weevil as a pest of processed and dry peas were continued in the Northwest in cooperation with the States of Washington, Oregon, and Idaho and interested growers, with gratifying results. The large-scale field experiments in the Blue Mountain area of eastern Washington and Oregon, in which dust mixtures containing rotenone were applied, yielded favorable results, as was the case last season. Comparative treatments showed that the use of hoods on large dusting machines increased the efficiency of these dust mixtures. No apprecable differences could be detected in the percentage of pea weevil control obtained with dust mixtures containing 1 percent as compared with those containing 0.75 percent of rotenone when the quantities of the dust mixture applied per unit area were practically equivalent. The results, however, indicated that under unfavorable climatic conditions or other restricting factors the dust mixtures containing less than 0.75 percent of rotenone might give a satisfactory degree of control. In the case of large acreages, the practice af treating border strips was followed to protect the rest of the field. In some instances "spot dusting" was practiced to reduce infestation. In the western Oregon and Washington pea-growing area where the pea fields are in smaller units, the entire field was treated, and infestation of the weevil was reduced to a minimum.

Additional numbers of the imported pea weevil parasite *Triaspis thoracicus* (Curt.), comprising approximately 20,500 living adults, were released in Idaho in 2 situations and under conditions that would appear favorable for establishment of this parasite. Although these parasites originated in Europe and were

[1] Samples of the rotenone-bearing materials, pyrethrum, and fluorine compounds used in all the experimental control work discussed in this report were analyzed by the Division of Insecticide Investigations of this Bureau, and the dilutions were based on these analyses.

reshipped to Moscow, Idaho, from Moorestown, N. J., they were received in Moscow in excellent condition and suffered a mortality of only approximately 5.7 percent of the numbers contained in the original shipment. Field collections to determine whether this parasite has become established in Idaho have yielded negative results thus far.

PEA APHID

During the springs of 1937 and 1938 the pea aphid was particularly troublesome in Maryland, Delaware, and New Jersey. Investigations were continued in Wisconsin on the control of this pest. In these control tests emphasis was placed on the time of treatment for maximum benefit in protection of the crop. Field and laboratory tests were continued with derris and cube dusts and sprays and the results show that these materials, applied either as a spray or a dust, appear to be the most satisfactory ones developed thus far for the control of this aphid. Adequate spraying or dusting equipment is essential to aphid control, as is proper material and time of treatment. A joint statement on pea aphid control, prepared by the workers in the several States where this insect is an annual problem and by Department entomologists, has been issued.

CORN EARWORM ON LIMA BEANS

Results of experiments conducted in Virginia to determine the relative effectiveness of various insecticides for the control of the corn earworm on Fordhook lima beans revealed that dust mixtures and sprays containing cryolite continue to be the most effective materials for the control of this pest. Of the three commercial brands of cryolite used in the experiments, imported synthetic cryolite and natural cryolite appear to be about equal in effectiveness, both brands being slightly more effective than the brand of domestic synthetic cryolite used in the experiments.

TOMATO INSECTS

TOMATO PINWORM

Investigations were continued on the tomato pinworm in California and the tomato fruitworm in California and Utah. The tomato pinworm continued to cause serious losses to the tomato crop in southern California and enlarged its known area of distribution to include Arizona. The results of tests during 1937 corroborated the fact that cryolite and cuprous cyanide, in either sprays or dusts, were the most effective stomach poisons used against this pest. Contrary to former belief, both cryolite and cuprous cyanide protected the treated plants effectively for a period of approximately 60 days following the last application. Large-scale field tests demonstrated that two applications of a spray or a dust mixture gave sufficient protection from a relatively light pinworm infestation, whereas five applications were required in fields where infestation was heavy. It was determined that to obtain best results applications should begin when the pinworms start forming leaf folds on the plants. During laboratory tests on tomato plants grown in pots and infested by the pinworm it was disclosed that the toxicity to this insect of a commonly used brand of natural cryolite increased, as the dilutions of cryolite increased, from 10 to 60 percent. At a 10-percent dilution approximately 69 percent of the pinworm larvae were killed, whereas at the 40-percent dilution approximately 97 percent perished. There was a distinct leveling off of the mortality curve at the 40-percent dilution. The toxicity of cuprous cyanide to the pinworm larvae also increased at progressive dilutions of 5, 10, 15, 20, and 30 percent. At dilutions below 30 percent pinworm mortality was less than 90 percent of the individuals tested.

TOMATO FRUITWORM

During 1937 work on the tomato fruitworm (*Heliothis obsoleta* (F.)) was continued with particular attention to control tests as well as biological studies designed to give information respecting the habits of the insect which have a bearing on its control. In California the most satisfactory insecticide found for use in combating the fruitworm was a dust mixture of equal parts by weight of cryolite and talc. Fairly satisfactory results were obtained with cryolite sprays at the rate of 4 pounds to 100 gallons of water, plus a suitable sticking agent, and with phenothiazine at the rate of 3 pounds to 100 gallons

of water. The best degree of control was obtained with the above-mentioned insecticides when three applications were made. The first application was made when the foliage of plants measured about 1 foot across and the second and third applications followed at about 2-week intervals, 10, 20, and 30 pounds, respectively, being used per acre. A bait prepared by thoroughly mixing 1 pound of cryolite or lead arsenate with 25 pounds of corn meal was approximately as effective as the dust mixture described previously. This bait was applied by hand, and an attempt was made to scatter it lightly and evenly over the leaves of the plants. Three applications of the bait were made corresponding with the time interval indicated for the dust mixtures. Approximately 40 pounds of the poisoned bait was used per acre for each of the first and second applications and from 60 to 70 pounds for the third application. The cost of the bait per acre is approximately the same as for the dust mixture, but the ease and speed of application without the use of special equipment met with general favor on the part of the growers.

SWEETPOTATO WEEVIL

The work on the sweetpotato weevil was expanded with research laboratory headquarters at Sunset, La. Biological and life-history investigations were initiated with special reference to those phases of the insect's life history and habits which would yield information pertinent to the control program on this pest. It was determined that when the sweetpotato weevil adults were given the opportunity to choose between young sweetpotato plants and sweetpotato roots, the adults fed almost exclusively on the roots, and all the eggs were deposited therein. In a series of field cages simulating natural conditions at two widely separated points in Louisiana during the winter of 1937–38 it was found that certain adults of the sweetpotato weevil lived as long as 118 days without food during the period extending from late in November to the latter part of March whereas other individuals lived as long as 86 days. In cages placed over green sweetpotato vines certain weevils lived for 92 days. The cages in question were placed in position in the fall of 1937 in the latter part of the sweetpotato harvest season and before the fields were cleaned. In general it was found that access to food prolonged the life of adults in the field. There was no appreciable difference in the adult survival between cages protected from direct precipitation and those exposed to precipitation.

While only a small percentage of the total adults used in these tests lived throughout the winter period without food, it appears that this phenomenon may occur in any season in southern Louisiana when conditions are favorable. Adults of the sweetpotato weevil emerged during March from decayed sweetpotatoes that had been exposed on the soil surface of infested fields in Louisiana from the time of harvest during the fall of 1937 to late in February 1938, at which time they were collected for observations on adult emergence. The fact that the adults of the sweetpotato weevil were able to survive under such conditions demonstrates the danger of leaving infested decaying sweetpotatoes in fields or storage banks where they may become a source of weevil reinfestation.

Observations in Louisiana to determine the results of the fumigation of weevil-infested seed sweetpotatoes in storage houses, bins, and banks by paradichlorobenzene, a chemical the use of which has been the subject of previous reports, showed that wherever the fumigation was performed properly the results were satisfactory.

EUROPEAN EARWIG

Encouraging results were obtained in the recovery of *Bigonichacta setipennis* (Fall.), the imported parasite of the European earwig, in Washington, Idaho, and Oregon. During the 4-year period 1934–37 this parasite has been liberated at 20 different points in these States. Recovery records at the close of 1937 indicated that it has survived at or near 15 of the colony sites. It is believed that it has been definitely established at the larger number of these colony sites, even in localities where the original liberation consisted of as few as 10 to 25 adults.

COLE-CROP INSECTS

Work on various species of worms attacking cabbage was continued in North Carolina, South Carolina, and Louisiana and on the turnip aphid in Louisiana. Investigations on cabbage worms attacking cabbage in Louisiana

and South Carolina continued to yield valuable information on methods of control. Results of insecticide tests directed against cabbage worms on cabbage grown in South Carolina during the fall and winter showed that a cabbage worm population consisting of the cabbage looper and various Agrotinae (principally the corn earworm and several species of climbing cutworms) can be controlled by the use of calcium arsenate-hydrated lime dust mixture (5 to 1) prior to the heading of the plants, followed by applications of a pyrethrum-talc dust mixture containing 0.3 percent of total pyrethrins, or a derris-clay dust mixture containing 1 percent of rotenone, at 10-day intervals after the plants have headed. While no significant differences were demonstrated between the yield of U. S. Grade No. 1 from the various treatments, highly significant correlations were shown to exist between the numbers of worms and the numbers of worm-damaged plants and, in the reverse ratio, between the numbers of worms and the numbers of plants free from worm injury. These experiments demonstrated again that the dust mixtures containing pyrethrum or derris were the ones most effective against the cabbage looper and that the calcium arsenate dust mixture was the one most effective against the Agrotinae.

The results of a survey of conditions relating to cabbage and cabbage worms in Louisiana indicated that the cabbage looper, the imported cabbage worm, and the larvae of the diamondback moth constitute 95 percent or more of the worm populations found on cabbage in that State, and that their relative importance is in the order named. It was found that the cabbage looper was the dominating factor on fall crops and that it appears late on spring crops. The imported cabbage worm was the most important, if not the most abundant, species on spring crops and ordinarily appears later on fall crops in damaging numbers. The larvae of the diamondback moth may become abundant on either the spring or the fall crop. The cabbage webworm, the cross-striped cabbage worm, and several species of Agrotinae are abundant on fall crops.

Studies in South Carolina on the seasonal occurrence of the principal species of cabbage worms on cabbage disclosed that the imported cabbage worm, the larvae of the diamondback moth, the cabbage looper, and several species of cutworms are more abundant during the spring months than during the fall and winter; that the populations of these species decrease to a marked degree during the fall when the mean temperatures are below approximately 50° F., and that they do not increase greatly in the spring until the mean temperatures are consistently above 60°; and that after the plants are thinned or transplanted the cutworms and the cabbage looper are the most abundant species during the fall months and the cabbage looper and the diamondback moth the most abundant during the spring. These studies also revealed that approximately two generations of each of the major species of cabbage worms developed during their more active periods in both the fall and the spring seasons.

BERRY INSECTS

Further tests against the strawberry weevil in the coastal regions of North Carolina indicated that a calcium arsenate-sulphur dust mixture remains the best available insecticide to use against this pest, since it greatly reduced the injury to fruit buds and gave an increased yield in the number of marketable fruits and culls. A dust mixture containing sulphur and hydrated lime also gave promising results in the reduction of injury to fruit buds, and resulted in an increase of marketable berries as compared with untreated plots. In a survey performed during the spring of 1938 in the strawberry districts of the Eastern Shore section of Maryland and in adjacent counties of Delaware and Virginia it was found that in the fields examined a range of from 16 to 81 percent of strawberry buds were cut as a result of strawberry weevil activity in fields examined in Sussex County, Del., from 17 to 67 percent of the buds were cut in three counties of Maryland, and a range of from 3 to 63 percent of the buds were cut in Accomac County, Va. In many fields the prevalence of drought and other unfavorable factors prevented the strawberry plants from developing the remaining uncut buds; consequently it was difficult to determine the exact economic status of the strawberry weevil in such fields.

Continued insecticide tests against the raspberry fruitworm in the Puyallup Valley, Wash., showed that satisfactory control of this pest could be obtained with three timely applications of sprays or dust mixtures containing rotenone, and that in general the sprays were superior to the dust mixtures in controlling the fruitworm.

Continued experiments in the control of the red berry mite (*Eriophyes essigi* Hassan) on blackberry in the Puyallup Valley demonstrated that following a spraying with lime-sulphur during the dormant period of the plant the application, during the fruiting stage of the berries, of sprays containing emulsions of refined petroleum oil was superior as a control for the mite to the application, when the fruit spurs were approximately 12 inches long, of sprays containing various compounds of sulphur. Despite the fairly satisfactory control obtained with sprays containing sulphur, the application of such materials caused reductions in yield of berries apparently due to the intolerance of the blackberry plant to sulphur. Some evidence also was obtained that the oil emulsions used in the sprays, although exerting a satisfactory control of the mite, caused reductions in yield through injury to the plant.

BEET LEAFHOPPER

Investigations on the beet leafhopper were continued in the intermountain region and in California. For the second time the migration of this insect was traced definitely from its breeding areas in southern Arizona to the western Colorado beet fields, indicating that this long-distance migration may be a normal annual occurrence.

Experiments, in cooperation with the beet-seed producers, having for their principal object the checking of the curly top disease in the beet plantings grown for seed in the Salt River Valley of Arizona demonstrated again that the pyrethrum-oil spray when atomized on the beets in the field will kill on an average approximately 97 percent of the leafhoppers.

In Idaho close attention was given to the development of the leafhopper in the desert area surrounding the cultivated sections, with the view of ultimately determining all factors responsible for favorable or unfavorable beet leafhopper conditions. Statements on the movements of the leafhopper from the desert area to the cultivated sections were prepared and made available to the beet and bean growers in the affected area. These statements simply give the facts on the leafhopper conditions as they obtain in the area at the time the statement is prepared, and there is no attempt to make predictions as to beet leafhopper infestations on the basis of overwintering leafhopper populations.

In Utah attention was directed to the development of means of protecting the tomato crop from leafhoppers and the resultant western yellow blight. It was found that the tomato is not a suitable host for the leafhopper although the leafhopper feeds occasionally on tomatoes during its movement from the desert host plant to suitable cultivated plants.

The surveys made in the Billings, Mont., district disclosed the presence of adult beet leafhoppers, indicating that during certain winters this insect is able to survive in this section of Montana.

In California the movements of the leafhoppers from the overwintering areas in the hills adjoining the San Joaquin Valley were followed again this season. The information accumulated on this phase of the study indicates strongly that if these critical breeding areas could be eliminated, or the leafhoppers killed through spraying or other similar treatments, this would reduce to a minimum the leafhopper damage in the San Joaquin and Sacramento Valleys, as it was definitely shown that the leafhoppers originating in the foothills of the San Joaquin Valley are responsible for damage in the Sacramento Valley.

TOBACCO INSECTS

TOBACCO FLEA BEETLES

Investigations on tobacco insects were continued in Connecticut, Florida, North Carolina, South Carolina, Tennessee, and Virginia. Field-plot tests and large-scale field experiments against flea beetles (*Epitrix parvula* (F.) and *E. cucumeris* Harr.) in Florida, Tennessee, North Carolina, South Carolina, and Connecticut corroborated the results of tests performed during previous years in indicating that wherever the value of the crop justified the use of this insecticide these pests could be controlled in the plant bed, as well as on newly set plants and on the growing crop, by timely applications of a dust mixture containing rotenone. Since the newly set plants are very susceptible to injury by the tobacco flea beetle (*Epitrix parvula*) in the areas of flue-cured tobacco, extensive tests were carried on to determine the most satisfactory method of protecting them after they were set in the field and until they had become well established. Treatment of the plants in the plant bed with arseni-

cals directly before they are pulled for setting in the field and treatment of the plants with the same materials after they are set in the field indicated quite clearly that these methods could be utilized to a distinct advantage in the protection of the newly set plants. As a result of quantitative sampling of hibernation media for overwintering adults of the tobacco flea beetle in several environments in North Carolina it was found that far greater numbers of the beetles per unit of area were present in old undisturbed tobacco fields than in fields in grass or the narrow strips along the edge of woods adjoining tobacco fields. In the tobacco fields the greatest numbers of flea beetles were found in the immediate vicinity of the old tobacco stalks.

TOBACCO HORNWORMS

During the latter part of the season in the North Carolina and South Carolina tobacco-growing areas hornworms became particularly abundant, and tests in the laboratory and in the fields where the tobacco had been primed showed that cryolite, either as a spray or as a dust containing 80 percent of cryolite (sodium fluoaluminate), was very effective against all stages of the hornworms. Cryolite mixtures containing less than 80 percent of cryolite were not effective, and the degree of toxicity decreased with the amount of cryolite contained in the dust mixture.

TOBACCO WEBWORM

Experiments performed in the dark fire-cured tobacco section of Tennessee showed that dipping the roots and root stalks of tobacco plants, prior to transplanting, in a liquid mixture containing a sufficient quantity of 85 percent cryolite to provide 1.9 percent of sodium fluoaluminate combined with a sticker was effective in reducing to a great extent the injury from the tobacco webworm (*Crambus caliginosellus* Clem.). Fish oil and mineral oil, each at the rate of 1.6 percent, animal glue at the rate of 0.37 percent, and billposter's paste at the rate of 0.75 percent were equally effective as sticking agents. The evidence from these experiments accumulated thus far indicates that dipping the roots of the tobacco plants constitutes a more effective control of the tobacco webworm than the corn meal-paris green-oil of mirbane bait which has been used heretofore in combating these pests.

CIGARETTE BEETLE

In experiments in Virginia designed to obtain information on an insecticide that might be used to combat adults of the cigarette beetle in tobacco warehouses of the open type it was found that pyrethrum dust mixtures containing a high percentage of pyrethrins were slightly more effective than the dust mixtures containing rotenone, but in no instance did the pyrethrum compounds give a percentage of kill that would be satisfactory in practical operations against the cigarette beetle adults in tobacco warehouses.

According to data obtained during the course of fumigation experiments against the cigarette beetle in Virginia it appears that a wide margin of error may occur in evaluating the efficiency of fumigants, particularly hydrocyanic acid gas, when used at relatively low temperatures in partial vacuum against the cigarette beetle infesting tobacco bales. In the instance of well-grown larvae of the cigarette beetle in which 3.9 ounces of liquid hydrocyanic acid was used per 1,000 pounds of tobacco a mortality ranging from 51.2 to 83.2 percent was attained at the expiration of the exposure period of 4 hours in partial vacuum. In test lots of cigarette beetle larvae thus fumigated and allowed to remain in the tobacco bales for 24 hours the percentage of mortality ranged from 67 2 to 82.4, for 48 hours it ranged from 91.2 to 96.8, and at the expiration of 67 hours it ranged from 90.4 to 100. To determine further the residual properties of hydrocyanic acid gas left in tobacco bales after fumigation in partial vacuum, test spikes containing cigarette beetle larvae were placed in bales of tobacco that had been removed from the fumigation tank after the customary aspiration of the tobacco bales had been applied. Examination of the test insects after 24 hours showed that the percentage of mortality ranged from 39.2 to 60, at the end of 48 hours from 39 6 to 67.2, and at the end of 67 hours from 56.0 to 87.2.

GREENHOUSE AND BULB INSECTS

Studies of greenhouse insects and pests affecting bulbs were continued at Sumner, Wash., Babylon, Long Island, N. Y., and Beltsville, Md. In the course of experiments directed against the gladiolus thrips in 1936 it was found that a combination spray consisting of tartar emetic and brown sugar gave a degree of thrips control equal to that obtained with the paris green-brown sugar spray and was not injurious to the gladiolus foliage. Moreover, it was shown that the tartar emetic-brown sugar spray did not have a deleterious effect on new corm production and that this mixture can be prepared at less cost than the paris green-brown sugar spray used formerly. The quantity of brown sugar used in this spray with the tartar emetic can be reduced approximately one-fourth over that used commonly with arsenicals without affecting the degree of control. Apparently sprays for the gladiolus thrips must be sweetened, however, since the substitution of a spreader and sticker for brown sugar in the spray mixture resulted in poor control of the gladiolus thrips when either tartar emetic or paris green was used as the principal ingedient.

In experiments performed on greenhouse-grown tomato and cucumber plants in which four sprays were applied at 4-day intervals against the common red spider and several species of thrips, principally the onion thrips, it was found that a derris spray having a rotenone content of 0.0056 percent was as effective as one with a rotenone content of 0.0112 percent; that the derris sprays used were superior to cube sprays of the same rotenone content; that the addition of pyrethrum extract aided in killing the thrips but did not improve the effectiveness of the sprays against the red spider; that with sprays of the same rotenone content containing sulphonated castor oil as a spreader the result was a better kill than when either alkylphenylbenzenesulphonic acid or rosin residue was used; and that a proprietary insecticide containing an aliphatic thiocyanate was as effective against the red spider as the derris spray plus sulphonated castor oil and did not harm the tomato plants, while a proprietary insecticide containing lauryl thiocyanate burned the plants severely after only two spray applications. In a second series of experiments, in which the same insecticides were used as in the first series but in which they were applied four times at weekly intervals, approximately the same results were obtained except that on the tomato the sprays containing derris, pyrethrum, and alkylphenylbenzenesulphonic acid appeared to be as effective as the sulphonated castor-oil sprays. The spray containing lauryl thiocyanate caused severe injury to both foliage and fruit of the tomato. None of the other sprays caused any permanent injury to either tomato or cucumber plants. On the whole a beneficial effect from the use of these sprays was clearly demonstrated, since on the sprayed plants the foliage remained greener and the plants continued to bear fruit much longer than on the comparable plants in untreated plots.

In cooperation with the New Jersey Agricultural Experiment Station, tests were conducted on the effect of high-frequency waves on the bulb nematode (*Ditylenchus dipsaci* (Kuhn) Filipjev). Negative results were obtained in these tests since no mortality to the bulb nematode resulted after exposures of 30 minutes in which waves of 12.5 and 42 meters, respectively, were used. The fumigation of narcissus bulbs with methyl bromide directed against the bulb nematode caused severe injury to the treated bulbs.

A survey of the bulb fields at Babylon, N. Y., to determine the percentage of infestation by the greater bulb fly showed the adults of the fly to be present in all fields examined, and from examination of bulbs in storage it was found that the percentage of infestation ranged from 0 to 54.5. Studies on the greater bulb fly were also conducted at Sumner, Wash., emphasis being placed on the control of the fly in the field. None of these tests yielded satisfactory control measures.

Japanese iris plants infested by the iris thrips which were held under conditions simulating transit for periods ranging from 7 to 10 days following treatment in hot water for 30 minutes at 110° F. to control the thrips grew as satisfactorily as those planted immediately after treatment. In the course of this experiment half the divisions of iris were planted immediately after treatment, whereas the others were packed in the same manner as for shipment, held for periods ranging from 7 to 10 days, and then planted. The foliage on the plants which were not set out immediately yellowed slightly and the new growth varied considerably in volume but the foliage developed satisfactorily during the year and was approximately equal to that of the iris planted immediately after treatment.

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Tests in Virginia to determine the practicability of the hot-water treatment to control the cyclamen mite on cyclamen under commercial conditions disclosed that the treated plants showed no evidence of injury, and compared with untreated plants reserved as checks they showed considerable improvement in growth and flower-bud development, indicating that the method of immersing plants infested by the cyclamen mite in hot water maintained at a temperature of 110° F. for a period of 15 minutes has a direct commercial application.

Satisfactory control of the greenhouse mealybug (*Pseudococcus citri* (Risso)) on Saintpaulia plants was obtained by dipping them in several different solutions containing organic thiocyanates.

MUSHROOM INSECTS AND MITES

Tests made against various species of mushroom flies (*Sciara* spp.), mites, and other pests in the mushroom houses at Beltsville, Md., with a number of drenches, including free nicotine (40 percent), nicotine sulphate (40 percent), alcoholic extract of pyrethrum (2 percent total pyrethrins), hellebore powder, and derris-root powder demonstrated that the drenches containing free nicotine or the alcoholic extract of pyrethrum gave the best results, as judged by yield. The mushrooms treated with nicotine drenches were found to contain from 0.009 to 0.222 grain of nicotine per pound. The mushrooms having the higher content of nicotine were picked while still wet, immediately after the beds had been drenched. The higher content of nicotine is the equivalent of approximately 32 parts per million. In 8 to 10 days after treatment analyses of the mushrooms revealed no nicotine present or only traces. In tests to determine the effect of hellebore and borax drenches as used for the control of house fly maggots it was found that the hellebore had no perceptible effect on subsequent growth of the mushrooms but that the borax drenches prevented mushroom growth. Small-scale tests in the laboratory in fumigating with methyl bromide disclosed that it was necessary to use a dose of 3 pounds of this material per 1,000 cubic feet to obtain a mortality of the species of mite commonly found infesting mushrooms, and that this dose appeared to cause considerable harm to the mushrooms and to the spawn.

SWEETPOTATO WEEVIL CONTROL AND ERADICATION

The project on sweetpotato weevil control was started at the beginning of the year. Operations were begun in Alabama, Georgia, Louisiana, Mississippi, and Texas in cooperation with these States. The control program was designed to eradicate the pest from areas of commercial production where wild host plants do not grow perpetually, to prevent spread to uninfested areas, and to protect eradication work already done.

Extensive surveys were conducted along the fringe of the known infested area to delimit the northern boundary so that control operations could start from the periphery and work gradually into the more heavily infested areas in which eradication will be more difficult because of climatic factors and wild host plants. In the States above mentioned 172 counties were surveyed, revealing 2,555 infested properties in 33 counties. Inspections of seedbeds, fields, storage, sweetpotato plants, and wild host plants were included in the survey.

Eradication activities included the destruction of infested seedbeds, clean-up of infested fields and storage, destruction of volunteer sweetpotato plants on infested properties and those adjacent, and the destruction of such wild host plants as *Ipomoea littoralis* and *I. pescaprae.*

COTTON INSECT INVESTIGATIONS

In March 1938 investigations of the pink bollworm and other cotton insects at Mayaguez, P. R., were discontinued. The results of investigations of the damage and status of the pink bollworm, its host plants, and its control in Puerto Rico and studies relating to other cotton insects and the West Indian blister mite have been published by the Puerto Rico Agricultural Experiment Station of this Department and in the Journal of the Department of Agriculture of Puerto Rico. The station at Brownsville, Tex., where cotton insects have been investigated during the winter months for several years was discontinued in March 1938. The investigations of boll weevil control on sea-island cotton conducted in cooperation with the State entomologist of Georgia in McIntosh County last year were transferred during the spring of 1938 to Chatham County with seasonal headquarters at Savannah. The seasonal laboratory started in Florida in the spring of 1937 for investigations of boll weevil

control on sea-island cotton in cooperation with the Florida Agricultural Experiment Station was changed to a full-time laboratory in the spring of 1938. The seasonal laboratory for conducting studies of sucking bugs attacking cotton, started at Mesa, Ariz., in the spring of 1937, was changed to a full-time sub-laboratory of the Tucson, Ariz., laboratory in the spring of 1938.

BOLL WEEVIL

The low ebb of damage reached by the boll weevil in 1936 continued during 1937 in all the States except Virginia, North Carolina, South Carolina, and Georgia, where the damage approached average. The low initial population combined with hot and dry weather during the critical period over a great part of the central Cotton Belt prevented the infestation from building up to injurious numbers until late in the season. At Tallulah, La., the rainfall during June, July, and August 1937 was only approximately half of normal and the lowest for any recent years except 1924 and 1930. Although the weevil population was low during the summer, rainy weather prevailed during the fall of 1937, and where the crop was not defoliated by leaf worms cotton continued to grow and weevils to multiply until late in the season.

The survival in hibernation cages during the winter of 1937–38 varied in different localities. At Florence, S. C., and Tallulah, La., the 1938 survival was only about one-tenth as great as in 1937. At Tifton, Ga., the survival was higher and at College Station, Tex., about equal to that of 1937. Emergence from hibernation also continued late into the season of 1938. At Florence emerged weevils continued to migrate to trap plots of cotton until July 6, and 34 percent of the total weevils were taken after June 15 or after squares were present.

In the experiments on boll weevil control conducted at Tallulah during 1937 smaller gains were made than for any year since 1924 because of the light infestation. In plots dusted with the standard calcium arsenate treatment the average increase in yield was only 78 pounds of seed cotton per acre, or 3.3 percent, as compared with an average for the 17-year period 1920–36 of 330 pounds, or 26.4 percent. Considerable attention was given in 1937 to mixtures of calcium arsenate with other materials that would control the boll weevil with smaller quantities of arsenic and at the same time control the cotton flea hopper, other sucking insects, and leaf worms. At Florence, the mixtures of calcium arsenate and lime (1 to 1 and 1 to 2) that have given good control in recent years of low weevil infestation were not quite so effective as straight calcium arsenate dust. Mixtures of calcium arsenate and sulphur in several proportions were tested at Florence, Tallulah, Tifton, College Station, and at Port Lavaca, Tex., against the boll weevil. The results secured were in general as good as with calcium arsenate dust, and at College Station and Port Lavaca the results were better than with calcium arsenate. Cryolite and barium fluosilicate used as dusts in field-plot tests showed little promise for boll weevil control. In experiments designed to compare the efficacy of several materials that might be used as sweetened poisons when mopping for boll weevil control, cane syrup and white corn syrup were slightly better than blackstrap molasses, the material commonly used, and superior to agar agar, glycerine, and water; casein, glycerin, and water; or blood albumen, ammonia, and water.

The increased plantings of sea-island cotton in Georgia and Florida have focused attention on the need of methods of controlling the boll weevil on this crop. Boll weevil control on long-staple cotton is difficult because it is later in fruiting than short-staple cotton, continues growth and fruits over a longer period, and has bolls that are softer and remain susceptible to weevil damage for a longer time. Tests in 1937 indicated that frequent dusting with calcium arsenate will control the weevil on sea-island cotton and also clearly indicated that mopping with sweetened poison does not give adequate control of these late weevils.

Small-sized plots consisting of one-twentieth to one-tenth of an acre, instead of the usual 1-acre plots, were used this year in the weevil-control experiments at several stations with fairly satisfactory results. Cage studies of the toxicity of calcium arsenates having different chemical and physical properties were continued. The highest weevil mortalities were obtained with calcium arsenate having the following properties: Coarse as to particle size, of low density, high water-soluble arsenic by the New York method, and low molar ratio CaO/As_2O_5. No significant relation was found between mortality and (1) angle of slope, (2) loose bulking value at constant weight or constant volume, (3) total As_2O_5, (4) water-soluble As_2O_5 by the method of the Association of Official Agricultural Chemists, and (5) free $Ca(OH)_2$.

SOIL INJURY FROM CALCIUM ARSENATE

The studies on the injurious effects to crops following the use of calcium arsenate, previously reported, were continued. The production of cotton on the plot at Tallulah, La., which received 400 pounds of calcium arsenate per acre per year from 1931 to 1935, or a total of 2,000 pounds, was practically the same as on the untreated plot. Austrian peas and hairy vetch, planted as winter cover crops in 1937, were severely stunted and produced only 46 and 69 percent, respectively, as much on the treated as on the untreated plot. Oats yielded 23 percent more weight on the calcium arsenate-treated plot. On the plots representative of seven major soil types of Mississippi the calcium arsenate has not materially affected the yield of cotton or corn, but the yields of hairy vetch, Austrian peas, soybeans, and oats continue to be seriously reduced on plots which received from 800 to 1,600 pounds of calcium arsenate per acre. Analyses of the arsenic in the soil and crops are made annually to determine the rate of reduction of the arsenic in the soil and the amounts absorbed by the crops.

COTTON FLEA HOPPER

Additional information was secured at Port Lavaca, Tex., on the proportions of sulphur and arsenicals for the best control of the cotton flea hopper and other insects. The greatest increases in yield were secured in 1937 from dusting with a mixture of 1 part calcium arsenate and 2 parts sulphur. The average gain from the 1-to-2 mixture of calcium arsenate and sulphur was 277 pounds of seed cotton per acre and from sulphur dust 230 pounds per acre. The profit from dusting with the mixture of calcium arsenate and sulphur was $9.98 per acre, and from sulphur alone it was $8.39 per acre. The results obtained in flea hopper-control experiments during the past several years were published in a circular.

The most important parasite of the cotton flea hopper has now been described as *Erythmelus psallidis* Gahan. Confirmation was secured during the year that this species overwinters in the eggs of the flea hopper. The overwintering state of another egg parasite (*Anaphes anomocerus* Gir.) has not been definitely established, but it apparently does not overwinter in the egg of its host. The importance of these parasites is shown by the fact that in 30,610 flea hopper eggs collected in 1937 from several hosts, 31.9 percent were parasitized, 18.7 percent by *E. psallidis* and 13.2 percent by *A. anomocerus*.

HEMIPTEROUS INSECTS

Additional experiments on the control of hemipterous insects attacking cotton in Arizona confirmed previous results that substantial increases in yield can be secured by the use of insecticides. Dusting with calcium arsenate, lead arsenate, and sulphur have all given large increases in yield against these sucking insects, but mixtures of arsenicals and sulphur have given the largest gains. In tests conducted at Yuma in 1937, plots dusted with sulphur gave an increased yield of 1,274 pounds of seed cotton per acre, or 55 percent more than the check; a mixture of calcium arsenate and sulphur (1 to 2) gave an increase of 2,333 pounds, or 100 percent; while a mixture of 10 percent of paris green and 90 percent of sulphur (1 to 9) gave an increase of 2,691 pounds, or 117 percent. In experiments at Mesa, where the infestation was very light, and at Buckeye, where the infestation was much less severe than at Yuma, the gains varied with the intensity of the infestation. Lint from the treated plots was much less stained and was increased in value several dollars a bale. As a result of this year's work, a tentative dusting schedule of five to nine applications of 15 to 18 pounds of either of the foregoing mixtures, applied at weekly intervals, has been recommended to the growers. Population counts and studies of host-plant relationships have shown that cotton is not the favorite host plant of this group of insects and that other plants such as alfalfa, sugar beets grown for seed, sorghum, and desert vegetation, are the principal sources of the populations on cotton.

PINK BOLLWORM

Breeding and colonization were continued with the three introduced pink bollworm parasites (*Microbracon kirkpatricki* Wilk., *Chelonus blackburni* Cameron, and the Hawaiian strain of *M. mellitor* (Say)). Liberations of the three species were made in Texas and Mexico and of *C. blackburni* in Puerto Rico. Although recoveries have been made near the points of liberation it is

still not definitely known if any of the species have become established. *M. kirkpatricki* has been found not to hibernate and it requires the presence of host larvae for continuous breeding during the winter. Conditions in the fields of the Big Bend section are not favorable for the survival of this species, and breeding was discontinued in the spring of 1938 after the liberation of approximately 75,000 adults. Part of these liberations were made in the boll weevil-infested area of southeastern Texas, since it has been determined that this parasite also attacks the boll weevil under laboratory conditions. *C. blackburni* overwinters in the long-cycle pink bollworms and emerges about the same time as the pink bollworm moths. A shipment of *M. nigrorufum* Cushman, a parasite of the pink bollworm, was received from Japan in April 1938, through cooperation with the Division of Foreign Parasite Introduction of the Bureau. The technique of breeding has been developed and mass production is under way.

In the studies of varieties of cotton best suited for growing under pink bollworm conditions the quick-maturing eastern varieties again gave greater yields and better grades of staple than the slow-maturing varieties. The varieties with small open-type plants and determinate growth which mature a large proportion of their crop early in the season were less damaged by the pink bollworm than the other varieties. A date-of-planting experiment showed that a wide spread in the time of planting, especially in fields in the same vicinity, results in severe pink bollworm damage to late-planted cotton.

Results of studies on the relation of different winter treatments to pink bollworm survival showed that heavy winter pasturing of cotton fields decreased the pink bollworm carryover. Early winter burial of infested bolls followed by a winter irrigation decreased the survival much more than winter burial without a winter irrigation. Where no winter irrigations were applied early winter burial gave a higher survival than late winter burial. Survival was also greatly influenced by depth of burial, the survival decreasing with the depth.

Continued tests with insecticides failed to disclose a method that will give satisfactory control.

COTTON LEAF WORM

In 1937 the cotton leaf worm was first reported in southern Texas on June 5, about 2 weeks later than in 1936. Spread to the north and east from this area was comparatively slow. Infestations were found in northern Florida and southern Alabama a month before they appeared in Louisiana or Mississippi and were apparently due to a separate migration of moths from the Tropics. Observations in Puerto Rico during 1936 and 1937 showed that this pest bred continuously on cotton but at no time became abundant. This insect does not overwinter in the United States and the origin of these annual migrations of moths is still unknown. The mixtures of arsenicals and sulphur used for flea hopper and boll weevil control also controlled the leaf worms.

Commercial calcium arsenates, grouped according to high, intermediate, and low mortalities to boll weevils, were tested for toxicity against fifth-instar leaf worms. The groups causing high and intermediate boll weevil mortalities each averaged 93 percent leaf worm mortality and the low group only 76 percent. The median lethol doses of six calcium arsenates, lead arsenate, paris green, and two mixtures of paris green and calcium arsenate were determined for fifth-instar leaf worms by a modification of the sandwich method. The median lethal doses for the calcium arsenates ranged from 0.12 to 0.72 milligram per gram of body weight; for a mixture of 7.5 percent of paris green and 92.5 percent of calcium arsenate, 0.09 milligram; for a mixture of 10 percent of paris green and 90 percent of calcium arsenate, 0.04; for lead arsenate, 0.02; and for paris green, 0.01.

BOLLWORM

Most of the damage by the bollworm in eastern Texas during 1937 was caused by the second generation of bollworms on cotton and consequently occurred late in the season. Better gains were again secured in the 1-acre plots by dusting with calcium arsenate than with the following other insecticides tested: Mixtures of calcium arsenate and sulphur (1 to 1 and 1 to 2); mixtures of sulphur and paris green (7.5 and 10 percent, respectively); barium fluosilicate; and sulphur with 20 percent of cryolite. Barium fluosilicate gave good control and increase in yield in a limited number of tests but the results from a cryolite-sulphur mixture were disappointingly low. In tests with plots of one thirty-second of an acre arranged in a Latin square the yields

indicated that calcium arsenate, calcium arsenate plus paris green (5 and 10 percent, respectively), and calcium arsenate plus 50 percent of sulphur were equally effective against the bollworm when the mixtures were applied at the rate of 7.76 to 9 pounds of calcium arsenate per acre. When the rate of application of calcium arsenate was reduced to 7 pounds per acre in a calcium arsenate-lime mixture the yield was likewise reduced. Pyrethrum and sulphur (0.09 percent pyrethrins I and II) was not effective against this insect.

THURBERIA WEEVIL

Studies on the changes in biology and habits of the Thurberia weevil when removed from its native host, *Thurberia*, and bred exclusively on cotton were concluded and the weevil eradicated from the field used for this purpose. Records of emergence of weevils from *Thurberia* plants growing under natural conditions in the mountains show a definite correlation with the occurrence of rains during July and August and further corroborate previous evidence that the infestations in cultivated cotton in the Santa Cruz Valley are due to a transfer from the *Thurberia* plants and not from a carry-over in the fields.

ROOT APHIDS

Investigations were continued on the aphids *Anuraphis maidiradicis* (Forbes), *Trifidaphis phascoli* (Pass.), and *Rhopalosiphum subterraneum* Mason attacking cotton. The three species are generally distributed throughout the cotton-producing sections of the Carolinas and Virginia and cause appreciable loss to cotton in these States. Control is difficult because of the large number of weed and cultivated host plants, the subterranean habits of the aphids, and the fact that they are attended by ants that move the stem mothers from place to place and start new infestations.

VARIETAL RESISTANCE OF COTTON TO INSECTS

An investigation of the varietal characters of cotton in relation to attack by the boll weevil, aphids, and thrips is being conducted at Stoneville, Miss., to secure basic information for use by plant breeders in developing varieties that are more tolerant or immune to insects. Excellent material is available at the Delta Branch Station of the Mississippi Agricultural Experiment Station in the collection of all the principal species and varieties of cotton grown for genetical studies and varietal tests. Of the 44 varieties of cotton studied, the varieties producing bolls of medium thickness were less damaged by the weevil than those with either thick or thin boll walls. A negative correlation was found between boll-wall thickness and toughness of the carpel lining as measured by a resistometer. No varieties or individual plants have been found that are resistant to aphid attack, although the increase in population on varieties with different degrees of pilosity was in direct proportion to the number of hairs on the lower leaf surfaces. Dusting with calcium arsenate increased the aphid population on all types of cotton, but the ratio of increase was greater on the glabrous varieties. Preliminary studies indicate that some varieties are more seriously damaged by thrips than others, but the factors responsible for these variations have not been determined.

PINK BOLLWORM CONTROL

The discovery of reinfestation by the pink bollworm in the Santa Cruz Valley of Arizona and also in Pinal County, Ariz., after a lapse of several years, and a rather general spread of infestation in the regulated areas, with an increase in the degree of infestation in the Pecos Valley in both Texas and New Mexico, were among the more important developments of the 1937 crop season. The infestations in the two Arizona areas are light, and they were brought under regulation on January 3, 1938.

REINFESTATION IN ARIZONA

Cotton plantings in the Santa Cruz Valley extend from near Nogales, in Santa Cruz County, northward to about 18 miles above Tucson, in Pima County. Most of the acreage is in the upper part of the valley, in the Marana section. The last previous infestation was found in the 1930 crop. The first specimens in the 1937 crop were found on November 2, additional specimens being taken

almost daily until November 17, when work was discontinued. By securing individual samples of trash at gins it was determined that infestation was general from the southern part of the valley northward to Rillito, but the results were negative for the Marana section.

Following discovery of the infestation, intensive inspections were begun in Pinal County. This county had previously been infested, the last infestation having been in the 1931 crop and the county having been released from regulations in December 1933. Conditions were ideal for inspections, and the fact that only one specimen was found indicates that the new infestation is extremely light.

In view of the discovery of a rather general pink bollworm infestation in southern Arizona, the question arose as to whether or not this insect was infesting *Thurberia* plants. To obtain information on this point several thousand *Thurberia* bolls were collected in November and December from various mountain ranges. The inspection of these resulted in the discovery of one specimen from bolls collected in the Rincon Mountains east of Tucson. Following this finding additional bolls were collected, but no further specimens were found. Over 88,000 *Thurberia* bolls were inspected.

SITUATION IN OLDER REGULATED AREAS

Weather conditions were unusually good throughout the season, and as a result very thorough gin-trash inspections could be made. In the lower Rio Grande Valley of Texas infestation was again established. To check on any possible build-up of infestation the work in Cameron County was divided into two periods. From July 7–31, 422 bushels of trash were inspected and 10 pink bollworms found. On August 20 and 21, 12 pink bollworms were taken from 73 bushels of trash, which indicates some increase. In addition, one specimen was taken in Hidalgo County, but results were negative in Willacy and Starr Counties. In the Texas Panhandle infestation was found in 6 counties, 29 specimens being found. This is a slight increase over the previous season. In the Pecos Valley of Texas there was a considerable increase in the number of specimens found; in fact, the records show this to be the heaviest infestation that has ever been found in that section. The same situation exists in the southern part of the Pecos Valley of New Mexico, but only one specimen was found in the northern part. In the El Paso, Mesilla, and Safford Valleys there was very little change. In the Deming area a general but light infestation was found throughout the cotton acreage.

A summary of the amount and results of the various types of inspection is given in table 9.

TABLE 9.—*Summary of inspections for the pink bollworm in regulated areas, crop season of 1937*

District	Gin trash		Field		Laboratory	
	Bushels	Pink bollworms	Man-days	Pink bollworms	Green boll samples	Pink bollworms
Lower Rio Grande Valley, Tex.	5,141	23	0	0	0	0
Texas Panhandle	6,001	29	0	0	73	0
Pecos Valley, N. Mex.	120½	181	(1)	14	81	12
Pecos Valley, Tex.	7½	623	0	0	68	7
Big Bend, Tex.	0	0	(1)	25	0	0
Hudspeth County, Tex. (southeastern part) [1]	10	1,367	0	0	20	1,252
El Paso Valley, Tex.[1]	3	31	0	0	127	83
Mesilla Valley, N. Mex.[1]	65¼	6	0	0	82	1
Tularosa, N. Mex.	0	0	0	0	0	0
Deming, N. Mex.[1]	7¼	143	0	0	24	100
Duncan Valley, Ariz., and N. Mex.	(2)		0	0	12	0
Safford Valley, Ariz.	580	26	0	0	25	0
Tucson, Ariz.[3]	1,473	52	(1)	7	0	0
Casa Grande, Ariz.[4]	4,550	1	0	0	0	0
Total	17,958½	2,482	(1)	46	512	1,455

[1] Incidental inspections.
[2] All cotton ginned in Safford Valley and inspections included under that district.
[3] 35 specimens of the Thurberia weevil were found.
[4] Some of the inspections made before area was placed under regulations.

CONTROL IN THE LOWER RIO GRANDE VALLEY

Mention was made in the last annual report that regulations enforced in the lower Rio Grande Valley would be somewhat modified. Instead of requiring each gin to install a sterilizer, large plants have been erected at various points in the district and all seed for milling purposes is heated to 155° F., after which it is allowed movement to any destination. Seed for planting purposes is stored in approved places until the end of the ginning season and is then sterilized by the State of Texas. A simple permit system is used, so the amount of unsterilized seed remaining in the district and the persons who have the seed are known at all times.

Owing to the mild climate, cotton plants are seldom killed by frost, and under usual conditions produce plenty of fruit to maintain the pink bollworm throughout the year. Therefore regulations were issued by the State of Texas providing that cotton stalks are to be destroyed after the harvesting season and not later than October 1. This would eliminate, during a period of some 6 or 7 months, any material on which the insect could propagate. Some 295,000 acres were planted to cotton in the 1937 crop, and on the whole very good cooperation was received in connection with the stalk-destruction program. One of the biggest difficulties was the fact that a considerable acreage is owned by nonresidents, and in some cases it was impossible to locate them. Incidentally, a similar program was carried out on the Mexican side.

CONTROL PROGRAM IN THE BIG BEND AREA OF TEXAS

In the fall of 1932 a special control program was instituted in the Big Bend to reduce a very heavy pink bollworm infestation and eliminate as much as possible the danger of spread to other areas. In brief, this program consisted of thorough clean-up of fields in the fall; delayed planting of the cotton crop the following spring, so that the peak of moth emergence would pass before cotton began fruiting; and the use of small plots of cotton to trap the later emerging moths. As mentioned in the last annual report, this program was abandoned for the 1937 season. A very heavy infestation developed in the 1937 crop, the damage being estimated by various farmers to be as high as 75 percent in some few cases, with the average being perhaps from 30 to 40 percent. Farmers requested that the program be resumed. This heavy infestation presents a grave menace to other cotton areas; therefore, early in 1938 the Texas Pink Bollworm Commission held a hearing at Marfa to consider what steps should be taken. As a result a 2-year plan of control was submitted and has been agreed to by the Federal and State departments, and farmers in the area have promised complete cooperation. Briefly, the plan is that all cotton in the fall of 1938 be picked and ginned as promptly as possible; that prior to October 1 all cotton stalks be cut and piled while still green, the stalks to be piled the same day they are cut and the piles burned as soon as the stalks are sufficiently dry; all storage places for cotton or cotton products to be thoroughly cleaned; and in the spring of 1939 no cotton to be planted prior to May 1.

INSPECTION OUTSIDE REGULATED AREAS

Conditions as a rule were especially favorable for inspection outside regulated areas. The territory covered during the 1937 inspection season was not so large as during the previous year, but about half again as much trash was inspected. Intensive inspections were made in northern Florida, southern Georgia, southern Alabama, southern and northwestern Texas, southwestern Oklahoma, and Maricopa and Pinal Counties, Ariz. The border cotton-growing areas of Mexico adjacent to the lower Rio Grande Valley of Texas were also inspected very thoroughly. The only findings other than the specimen at Casa Grande, Ariz., were in Mexico. In the Matamoros area, which is opposite the lower Rio Grande Valley of Texas, considerable inspection was done. Specimens of the pink bollworm were found on the first day and almost daily thereafter. Inspections began on July 20 and were continued through July 28, 338 specimens being found in the 287 bushels of trash examined. In the Don Martin project, an important cotton section, results were negative. In the Juarez Valley, which is opposite the El Paso Valley of Texas, some incidental inspections of trash were made by hand and specimens readily found. A summary of the amount and results of the various kinds of inspection is given in table 10.

TABLE 10.—*Summary of inspections for the pink bollworm outside regulated areas, crop season of 1937*

State	Gin trash		Field		Laboratory	
	Bushels	Pink bollworms	Man-days	Pink bollworms	Samples	Pink bollworms
Alabama	3,411	0	0	0	0	0
Arizona	12,508	0	0	0	0	0
Florida	1,878	0	(1)	1	595	0
Georgia	7,954	0	0	0	582	0
New Mexico	0	0	0	0	99	0
Oklahoma	5,873	0	9	0	141	0
South Carolina	740	0	0	0	0	0
Texas	53,811	0	0	0	1,322	0
Total	86,175	0	9	1	2,739	0
Mexico:						
Chihuahua [2]	4	48	0	0	0	0
Nuevo Leon	1,631	0	0	0	0	0
Tamaulipas	732	665	(2)	32	0	0
Total	2,367	713	0	32	0	0
Grand total	88,542	713	9	33	2,739	0

[1] Incidental inspection of experimental plots of cotton on the city of Miami farm. All the cotton was destroyed immediately after this specimen was found.
[2] Incidental inspections.

WILD COTTON ERADICATION

The eradication of wild cotton in southern Florida was continued. This work was begun in 1932 to eliminate a rather heavy pink bollworm infestation and thus remove the danger of spread to the main Cotton Belt. Owing to climatic conditions effective work can only be done during the fall and winter and early in the spring. The past season was unusually favorable for eradication work. A deficiency in rainfall made working conditions more agreeable, helped to keep down insects, retarded the growth of wild cotton plants and other vegetation, and made it possible to reach some locations which are ordinarily rather difficult. The upper west-coast counties were cleaned 3 times, and only 81 plants containing mature fruit were found. The Ten Thousand Islands section, which is perhaps the most difficult to work in the entire district, was cleaned twice. As a result of a survey made with an autogiro during the spring of 1937, 14 new colonies of wild cotton, covering 59 acres, were located and cleaned. One of these colonies in Collier County was infested with the pink bollworm. The Cape Sable and Florida Bay sections were cleaned twice, the mainland keys were also cleaned twice, and some of the colonies were cleaned three times. In the Florida Bay section two new colonies were located and cleaned. This makes 16 colonies which were located and cleaned for the first time. They covered approximately 71 acres and contained 1,129 mature and 1,218 seedling plants. During the recleaning 1,127,183 seedling and 3,511 sprout plants were removed. In addition, over 15,000 acres were scouted without any wild cotton being found. In view of the surveys that have been made it is believed that all wild cotton has now been located and cleaned. The work hereafter will consist in cleaning the various colonies before any of the plants can mature and shed seed. This procedure has been followed for several seasons in the counties nearest cultivated cotton, and there has been a very noticeable decrease in the number of seedling plants that come up each season.

THURBERIA WEEVIL CONTROL

That part of southern Arizona infested with the Thurberia weevil has been under regulations for a number of years, and similar control measures are used for both the pink bollworm and the Thurberia weevil. The host of the weevil is *Thurberia thespesioides*, a plant which grows in various mountain ranges. Approximately 6,000 acres are planted to cotton, and each season a few weevils have been found. During the past season 35 weevils were found as a result of gin-trash inspection.

In 1935 emergency relief funds were used to attempt eradication of *Thurberia* plants in the nearby mountain ranges and thus remove the menace from cultivated cotton. This work has been carried on continuously since it was begun. The range nearest cultivated cotton was first cleaned, after which work was begun in the Santa Catalina Range, which is next nearest, and all work during the past season was in this range. Work was carried on from a camp in the mountains, and as various sections were completed the camp was moved from time to time. During the year 19,600 acres were covered and 106,034 *Thurberia* plants destroyed. The majority of these plants were infested with the Thurberia weevil. Since work was begun 200,150 acres have been covered and 1,320,042 *Thurberia* plants destroyed.

BEE CULTURE

In March 1938 a new field laboratory was opened at Madison, Wis., in cooperation with the Wisconsin Agricultural Experiment Station and the University of Wisconsin. Beekeepers, acting under the agency of the American Honey Producers' League, assisted in establishing this laboratory by donating hives and bees. Immediate work assigned to the new laboratory includes problems of supersedure and package bees in commercial honey-producing apiaries, especially under conditions encountered in the North Central States.

In the study of resistance to American foulbrood, colonies headed by line-bred queens of strains showing resistance made a better showing when inoculated with American foulbrood than did colonies headed by queens of any one of these strains mated with drones from the other strains. During the spring of 1938 some 2,500 queens of resistant stock were reared for distribution among beekeepers for testing under commercial apiary conditions.

In studies of the intestinal tracts of bees fed honey infected with spores of *Bacillus larvae*, the causative organisms of American foulbrood, such spores were recovered from the rectal ampullae of worker bees and then grown in culture. This indicates a possibility that the excreta of diseased bees may be a means of spreading the disease.

An easily prepared culture medium for *Bacillus larvae* was devised that possesses distinct advantages over media previously used in the Bureau. For example, growth of *B. larvae* was obtained with it when the number of spores present averaged only 1 per cc, whereas in the past the minimum number with which growth could be obtained in culture has been held to be 50,000 per cc. The way now seems open for making single-spore cultures for studies of pure strains.

Commercial high-test lye, in various concentrations ranging from 1 pound in 1 gallon of water to 1 pound in 30 gallons, proved to be a relatively weak disinfectant for spores of *Bacillus larvae* at both 37° and 70° C. Spores exposed to boiling in water appeared to become attenuated, and the use of larger inocula was necessary to obtain growth in culture than is the case with untreated spores.

A total of 1,041 samples were received for disease diagnosis and inspection. These included 789 samples of brood and 66 of the dead or abnormal adult bees, as well as 186 imported queens submitted for inspection of their attendants for the mite *Acarapis woodi* (Rennie), in accordance with existing regulations.

In the breeding work a satisfactory X-ray dosage for queens was determined and three mutations resulted, but none was held suitable for use as genetic markers. Attempts to mate bees within a copper-screen enclosure 20 by 20 by 20 feet were unsuccessful. The unmated queens and drones appeared to fly freely from, and to return to, hives within the enclosure, but the drones invariably flew against the cage walls repeatedly or rested on them while absent from their hive. No apparent attempt at mating was observed.

Studies of the cubital indices of various races so far have consistently given lower values for the Caucasian than for other races.

Cooperative work with the Oregon Agricultural Experiment Station showed wide variation in the quantity of nectar produced by different varieties of pear trees in the Rogue River Valley in Oregon. The Bosc, Anjou, and Comice, varieties that present a pollination problem, produced only meager quantities. The amount of nectar produced by pear trees was observed to increase with temperature, but the percentage of sugars in it remained low in comparison with that in nectar of other flora competing for the attention of the honeybee. Bees obtained considerable pollen from the blossoms early in the morning.

A chemical analysis of various pollens to determine their relative food values for the honeybee was undertaken in cooperation with the division of chemistry of the University of California. So far the protein and fat content has varied

widely in different pollens. The pollens collected for study vary in color throughout most of the range of the visible spectrum. Carotin was found associated with orange-colored pollens.

In a study of the effect on a colony of removing a portion of its bees, as occurs when a colony is used for package-bee production, the resulting population of test colonies from which 3 to 4 pounds of bees were removed every 10 days for a 3-month period this spring apparently was not materially reduced below that of colonies from which only 2 pounds of bees were removed, or even below that of check colonies from which no bees were removed.

Work in cooperation with the division of chemistry of the University of California showed that the treatment of beeswax with citric, oxalic, and phosphoric acids will remove metal stains and restore the yellow colors without seriously affecting the acid number. The acid can be removed by washing with hot water although when this is done the wax becomes slightly harder. Beeswax has been separated into six fractions at various temperatures from 0° to 70° C. These fractions ranged in hardness from that of vaseline to that of rosin. The coloring materials were contained in fractions removed at lower temperatures. Propolis, a common contaminator of beeswax, was shown to be a variable material having a higher acid number, iodine number, and density but a lower saponification number than beeswax.

Field surveys continue to emphasize the importance of the supersedure problem and the necessity of having hardy queens of good stock for use with package bees. Thus, of the queens in 143 packages established by the field laboratory at Madison, Wis., 2.8 percent were lost during introduction, 3.5 percent failed to lay, 3.5 percent were lost during the first week, 4.9 percent during the second and third weeks, 1.4 percent during the fourth and fifth weeks, and 4.2 percent during the sixth and seventh weeks, making a total of 20.3 percent. Of the queens still retained in the colonies at the end of the seventh week those classed as inferior amounted to 19.6 percent of the original number.

The work on supersedure resulted in the publication of a method for installing package bees which includes spraying both package bees and queens with sugar sirup, thereby permitting the direct release of the queen among the package bees and the commencement of egg laying with a minimum loss of time. In certain field studies the time required for initial egg laying by package queens was reduced from an average of 4.2 days to less than 1 day by use of this method.

In an effort to determine whether conditions surrounding the development of the queen play any part in supersedure, the physiological and chemical investigations on the growth and development of queens and workers were largely completed. The chemical studies included an analysis of the nitrogen, lipid, and carbohydrate content. Royal jelly was found to contain 20 units of vitamin B per gram, but vitamin A is absent. The biological value of the protein content is 75 percent. Royal jelly was also found to possess definite bacteriostatic and bactericidal properties. Since it has been ascertained that both worker and queen honeybees develop at approximately the same rate during the first 4½ days of larval life, after which the workers' development is retarded, it would appear that either a qualitative or a quantitative dietary deficiency is a contributing factor in causing the dimorphic condition.

The studies on vitamins A and B in royal jelly were carried on in cooperation with the Bureau of Chemistry and Soils while the germicidal studies were conducted in cooperation with the bacteriology department of Louisiana State University.

Studies on the lethal effect of insecticides on the honeybee showed that 2 micrograms of calcium arsenate or of arsenic pentoxide was sufficient to reduce the longevity of caged honeybees 50 percent as compared with the longevity of control bees. For lead arsenate the corresponding figure was 10 to 15 micrograms. Phenothiazine did not reduce the longevity to this extent, even when more than 500 micrograms per bee was fed. Phenothiazine was considerably repellent to bees, whereas lead arsenate and calcium arsenate were only slightly so.

INVESTIGATIONS OF INSECTS AFFECTING MAN AND ANIMALS

SCREWWORMS AND BLOWFLIES

To expedite the testing of materials as protectors against screwworm infestation of wounds in various classes of livestock and to give experimental conditions more directly comparable with those on ranches a 1,300-acre tract was leased near Menard, Tex. This land, which is typical of the ranches of that area, has been stocked with about 1,300 sheep and goats and a few other livestock for use in the experimental work.

Previous work had shown that phenothiazine is an excellent material for killing young screwworm larvae infesting a wound, and that this chemical would protect the wound against subsequent infestation for a considerable number of days. Since phenothiazine, however, is relatively nontoxic to screwworms over 3 days old, search has gone forward to discover a chemical having the protective properties of phenothiazine and yet toxic to all stages of screwworms. During the season 1937–38 approximately 550 different organic compounds were tested, of which 46 were shown to possess greater toxicity to screwworms than phenothiazine. Three of the latter were indicated to be of exceptional value for the prevention and treatment of screwworm cases in range livestock.

Two important developments in the investigation of methods for controlling horn flies give promise of providing means of greatly reducing screwworm cases predisposed by these flies. One of these, a unique discovery in insect-control methods, consists in feeding animals phenothiazine. Most of this chemical is unabsorbed by the animal and passes out with the undigested contents of the alimentary tract, and its presence in the manure prevents the development of horn fly larvae therein. This finding appears to have possibilities in meeting the problem of horn fly control in range areas where the disposal of manure to prevent fly breeding is not practical. The other method of horn fly control resulting from the year's work was the development of an automatically operated fly trap. One year's practical test with the device indicates that it will provide an inexpensive and efficient method of ridding dairies, feed lots, and fairly large ranches of the pest.

In cooperation with the Bureau of Animal Industry investigations were begun to find a treatment for screwworm-infested animals which would promote healing of the injuries and thus reduce the expense of feeding and treating wounded animals over a relatively long period.

Continued observations on the overwintering habits of the primary screwworm fly (*Cochliomyia americana* C. and P.) showed that in southwestern Texas the pest survived the winter of 1937–38 south of a line from Uvalde westward to the Rio Grande and up the valley of the Pecos River as far north as Sheffield; in the Southeast, from Valdosta, Ga., southward; and in Arizona throughout the southwestern part of the State.

Dispersion of the primary screwworm fly from the overwintering area, which apparently began in March, reached its northern limit, a line extending from Oklahoma City, Okla., to Amarillo, Tex., and Tucumcari, N. Mex., by July 18. Dispersion eastward reached western Louisiana about July 1 and north-central Louisiana about August 1. The rate of migration of the pest was somewhat slower in a northerly direction in 1937 than in 1936 but was more rapid toward the east. Migration was uniformly progressive until the first of August, when the hot, dry weather in the north and excessive rainfall in eastern Texas and Louisiana stopped further movement.

In certain sections of the Southwest several species of ants, especially those belonging to the genera *Eciton* and *Pheidole*, destroy from about 65 to 90 percent of the larvae and pupae of *Cochliomyia americana* that develop from the carcass of an animal that has died of a screwworm infestation. Histerid beetles are not known to destroy screwworm larvae but they devour large numbers of the larvae of other blowflies present in a carcass.

It is indicated that from 50 to 90 percent of the larvae and pupae of screwworm flies are destroyed by natural agencies.

Temperatures considerably affect the populations of various genera of blowflies. In a period having a mean monthly range below 50° F. species of *Calliphora* and *Cynomya* predominate, between 50° and 70° species of *Phormia* are the most abundant, and with temperatures above 70° species of *Cochliomyia* are most numerous.

Research on the factors which induce screwworm flies to oviposit on wounds of animals showed that there is a close correlation between the pH value of

the wound secretions and the degree of attractiveness of the wound for the flies. The greater the alkalinity within certain limits, the larger the number of eggs deposited.

FLY SPRAYS

Research in perfecting insecticidal sprays for the protection of livestock against biting flies resulted in the finding that careful selection of the base mineral oils within certain boiling-point ranges greatly increases the killing power of the spray. It was also discovered that the use of certain vegetable oils having no toxicity to insects in themselves materially enhances the lethal effect of pyrethrum and other insecticides when these are combined with the oils in an insecticidal mixture.

INSECT-BORNE DISEASES

With the devastating outbreak of equine encephalomyelitis in the North Central, Western, and Southwestern States during the summer of 1937 which resulted in the death of some 45,000 animals, the Bureaus of Animal Industry and Entomology and Plant Quarantine cooperated in an effort to determine the species of insects responsible for the transmission of the disease. Although certain species of culicine mosquitoes appeared to be the vectors in parts of the Southwest, the epizootic died out before conclusive data could be obtained.

An epidemiological survey of a disease of domestic turkeys in the Southeast showed a high incidence of the disease in that area, and that the disease is apparently responsible for a heavy mortality among young birds.

HOUSEHOLD AND STORED-PRODUCT INSECTS

In addition to a large amount of work of a public-service nature in supplying information to individuals and commercial concerns on methods of controlling household and stored-product insect pests, assistance was given the Army, Navy, and C. C. C. in fumigating barracks for the eradication of bedbugs and other vermin. Cooperation was extended the Procurement Division of the Treasury Department and other Government agencies for the protection from insect damage of commodities in storage.

A number of Government publications giving information on the control of insects in the household were prepared during the year.

Because of the increasing demand of manufacturers for a substance which will impart a moth-resistant quality to woolen fabrics, an intensive study was begun to determine which chemicals not under patent at the present time would be suitable for this purpose.

Neogastrallus librinocens Fisher, a new pest of books and papers, was discovered to be causing extensive damage in libraries in Florida. Although this pest has probably been present in the United States for a number of years, this is the first time that it has been recorded, and the first evidence of the seriousness of the damage it can cause in this country.

TICKS AFFECTING MAN

Because of the increased abundance of the American dog tick and the incidence of the eastern form of Rocky Mountain spotted fever which it carries in the East, a laboratory was established at Vineyard Haven, Mass., in July 1937 for investigating the control of this tick. The tick, besides being a vector of disease, is a serious pest of man and dogs in most of the States east of the Rocky Mountains. Sporadic cases of spotted fever have been reported from practically every State in which the tick occurs.

The problem of controlling the tick is complicated by the fact that its immature stages are parasitic on small wild rodents, whereas the adults attack larger animals, the dog being the principal host.

Various control methods are being tested as rapidly as possible. The principal lines of attacking the problem are (1) the poisoning of rodents to eliminate the hosts of the immature ticks, (2) controlled burning of brush and undercover vegetation to destroy dormant or inactive stages of the tick and to remove favorable haunts of rodents, (3) systematic treatment of dogs in an area to destroy the adult ticks, (4) the use of tickicides and repellents sprayed on vegetation for ridding relatively small areas of the pest, and (5) the use of insect parasites of the tick.

Experiments on control of the tick during the year gave encouraging results. It was found that spraying vegetation with nicotine sulphate (1 to 200) will effectively rid an area of ticks for approximately 3 days.

MOSQUITOES

Research on the biology, habits, and ecological relationships of mosquitoes showed, in the case of certain floodwater species in the Pacific Northwest, that there is a close relationship between temperature and percentage hatch of the eggs. In midwinter five alternate dryings and floodings of the eggs in the soil are required before they will all hatch, whereas in April, May, or June, after the eggs have passed their winter in dormancy, a single flooding will cause all of them to hatch. Eggs that would normally hatch on the first flooding during the period from June to August will become dormant again in September, after which more than one flooding is required to make them hatch. Observations also showed that the eggs may change from the winter dormant stage as early as April 20 in early seasons and as late as June 8 in late seasons. Therefore flood crests that occur before these dates do not cause the hatching of all viable eggs.

Additional data obtained during the past season demonstrated that eggs of the flood water mosquitoes *Aedes vexans* (Meig.) and *A. aldrichi* D. and K. may remain viable in the soil for at least 4 years under natural conditions.

The development of a machine for separating mosquito eggs from soil and a careful study of the differences in characteristics of the eggs of various species have greatly increased the rapidity with which studies on the biology of the more important forms can be completed.

Among the more important developments on methods of controlling mosquitoes during the year the following may be cited:

(1) The addition of 10 percent of pine oil to a pyrethrum-base oil mixture increased the mortality of mosquito larvae (*Culex quinquefasciatus* Say) from 7 to 65 percent and from 34 to 72 percent after the larvae had been exposed to the action of the larvicide for 1 and 24 hours, respectively. A pine-oil activator (10 percent) added to a pyrethrum-base oil mixture increased the mortality of mosquito larvae from 7 to 89 percent and from 34 to 96 percent after 1 and 24 hours' exposure, respectively.

(2) Waste crankcase oils are in general unsuitable as mosquito larvicides. Their toxicity can be increased by the addition of such materials as kerosene, 5 percent of crude cresylic acid, and 5 percent of a light coal-tar creosote oil containing 12 percent of tar acids and 34 percent of crude naphthalene, but even with this increased killing capacity they are not any more effective than fresh fuel oil or Diesel oil and are more expensive.

(3) Cashew-nutshell oil is a promising new mosquito larvicide. Applications of this oil at the rate of 12.5 gallons per acre of water surface result in killing 85 to 95 percent of the larvae.

Cooperation with the Bureau of Biological Survey and the Civilian Conservation Corps relative to the mosquito-control work of C. C. C. camps in New Jersey, Delaware, and Maryland was continued. In addition to the technical advice given on methods of mosquito control on various types of salt marshes, observations were made on the effectiveness of ditching in the control of salt-marsh-breeding mosquitoes, the effect of the ditching on the flora and fauna of salt marshes, and the influence of this method of mosquito control on wildlife.

Changes in marsh fauna as a result of ditching are dependent on the extent of flooding to which the marsh is subject. Ditched marshes which have regular tidal floodings appear to have practically the same numbers of animals suitable for wildfowl food per unit of area as do unditched marshes. Because the effect of ditching on the physical and chemical characteristics of the soil and the water level is so varied in different marshes, and in different sections of an individual marsh, it is indicated that a thorough study of marsh conditions should be made before ditching is begun.

A compilation of data secured over a period of several years furnished material for a comprehensive manuscript, now in course of publication, on the taxonomy, biology, habits, and control of the mosquitoes in the southeastern part of the United States.

INSECT IDENTIFICATION

The total number of identifications made and reported was 66,006, of which approximately 36 percent were for the Division of Foreign Plant Quarantines and 38 percent for the remaining divisions of the Bureau and other Federal

units, while the balance were distributed among agencies of the various States and insular possessions, individuals of the United States, and foreign institutions and individuals. Approximately 1,200 lots remained unfinished at the end of the year. This is the smallest number of uncompleted lots on hand at any one time for several years and indicates definite improvement in expediting identifications, for which an increase in staff during the year is largely responsible. To facilitate and expedite the identification of material taken in connection with the white-fringed beetle survey in the Southern States a special identification project was established at Gulfport, Miss., late in the year. As usual, assistance in taxonomic problems has been rendered numerous outside investigators, and considerable attention has been given to the maintenance and improvement of the extensive insect collections that are essential for reference purposes in connection with identification work.

The time not required for service activities was devoted to research studies on various taxonomic and morphological problems in order to improve the classification in different insect groups and so to make possible more definite and complete determinations. Forty-seven manuscripts were completed, of which 30 were published. In addition, considerable work was performed on a number of extensive studies that were not completed. Included in this group are the following: Classification of the white grubs; revision of the bark beetles of the genus *Hylastes;* revision of the weevils belonging to the genus *Pantomorus;* revision of the wood-boring beetles of the genus *Chrysobothris;* classification of the American moths of the subfamily Phycitinae; revision of the moths of the family Oecophoridae; revision of the fruitflies of the genus *Anastrepha;* revision of the blowflies of North America; revision of the parasitic wasps of the genus *Ophion;* revision of the North American bees of the genus *Osmia;* generic classification of the leafhoppers of the family Cicadellidae; revision of the plant lice of the genus *Myzus;* synopsis of the scale insect genus *Cerococcus;* monograph of the scale insects of the genus *Asterolecanium;* catalog of the North American moths of the family Noctuidae; generic revision of the North American thrips; catalog of the Anoplura or sucking lice; study of the male genitalia in the Hymenoptera.

FOREIGN PARASITE INTRODUCTION

The foreign work of parasite introduction was centered, as heretofore, at the field stations at St. Cloud, France, and Yokohama, Japan. Activities in Europe on the pine shoot moth and larch casebearer have been completed, and a study of the spruce sawfly begun. In the oriental field extensive work on natural enemies of the pink bollworm was undertaken, while the emphasis in the oriental fruit moth work was changed from the collection and shipment of parasites to field studies.

A parasite-receiving station was established at Moorestown, N. J., for the quarantine handling of imported material. Shipments from the various foreign countries are received at this station and, if living host material or hyperparasites are included, the adults are reared and only pure colonies of the desired species forwarded to the field stations for liberation. Thirty-three shipments were received from foreign sources and 48 shipments, principally of reared material, transmitted to the Bureau's various field stations for colonization. In addition, eight consignments of parasite material were prepared and forwarded to foreign countries.

A study was undertaken of the effect of chemical and other control methods on the population of parasites, predators, and other natural controlling factors of a series of insect pests. Certain insecticides are very detrimental to the development of the natural enemies, while others have little or no effect upon them. Field stations were established at Moorestown, N. J., Orlando, Fla., and Whittier, Calif., and the pests under investigation are the codling moth, strawberry leaf roller, a series of citrus scale insects, and the citrus whitefly.

PARASITES OF CEREAL AND FORAGE INSECTS

The importation program followed closely that of 1937, with attention paid primarily to parasites of the hessian fly and the European corn borer. Of the first-named, 1,220 adults of *Trichasis remulus* (Walk.) were secured in France and shipped as adults. Parasite work on the corn borer was restricted to securing *Phaeogenes nigridens* Wesm. in Italy. A total of 7,280 host pupae containing the parasite were forwarded late in the summer of 1937. In addition, 1,050 adults of *Chelonus annulipes* Wesm. were received from the Canadian

Department of Agriculture. A shipment of 1,880 adults of *Collyria calcitrator* Grav., a parasite of the black stem sawfly, was received from the same source.

A consignment of 545 field-collected cocoons of *Heterospilus cephi* Roh., a parasite of the European wheat-stem sawfly, was forwarded to the Department of Agriculture of Canada.

Studies were made of the parasites of the vetch bruchid and it was determined that *Triaspis thoracicus* (Curt.), previously imported against the pea weevil, also attacks the vetch bruchid. Accordingly some of the imported material is being utilized against this species.

PARASITES OF COTTON INSECTS

Late in the fall of 1937 a total of 872,340 pink bollworm larvae were collected in Chosen and stored at the Yokohama, Japan, station for parasite development the following spring. From this quantity of host material parasites were reared and shipped to the United States as shown in table 11.

TABLE 11.—*Parasites of the pink bollworm reared in Japan and shipped to the United States in 1938*

Species	Cocoons	Adults	Total
Microbracon nigroruſum Cushman	93,481	832	94,313
Habrobracon pectinophorae Watanabe	1,607	----------	1,607
Chelonus pectinophorae Cushman	----------	154	154
Pristomerus sp.	----------	19	19
Total	----------	----------	96,093

PARASITES OF FOREST INSECTS

Work on parasites of the pine shoot moth and larch casebearer in Europe was brought to a close with the completion of the 1937 collecting program in the Netherlands. In the spring of 1938 an investigation of the spruce sawfly was started in northern Europe. The survey is being made in all countries north of Czechoslovakia to determine the distribution of the pest and the ecological relationships of the pest and its parasites, and to locate new areas for large-scale collection. Promising infestations have already been found in northern Sweden and at the northern limit of spruce growth. This study is in cooperation with the Canadian Department of Agriculture, which has been conducting large-scale collections in central and southern Europe for a period of years.

In Japan collections of sawfly material were made and a shipment of 24,831 field-collected cocoons of *Neodiprion sertifer* (Geoffr.), with 693 tachinid puparia, were forwarded to the Canadian Department of Agriculture. Shipments of European spruce sawfly parasites from that organization to the Bureau totalled 1,300,000 adults of *Microplectron fuseipennis* (Zett.), 8,579 *Exenterus abruptorius* (Thunb.), 120 *E. adspersus* Hart., and 20 *Microcryptus* sp.

One consignment consisting of 1,326 field-collected egg masses of the elm leaf beetle was shipped from Japan to the California College of Agriculture, and from them 5,038 *Tetrastichus* sp. were secured for colonization.

PARASITES OF FRUIT INSECTS

The large-scale importation of oriental fruit moth parasites from Japan and Chosen, initiated in 1932, was discontinued at the end of the 1937 season, shipments during the latter half of that year consisting of 6,237 adults and 2,686 cocoons of 7 species of hymenopterous parasites and 130 tachinid puparia. The 1938 season is being devoted to a study of alternate hosts of the parasites, which appear to be essential to the establishment and maintenance of several of the more important species, and to surveys of new areas. A shipment of 201 cocoons of *Gambrus stokesii* Cam. was received from Australia through the courtesy of the Council for Scientific and Industrial Research.

PARASITES OF TRUCK CROP INSECTS

Shipments of parasites of the lima bean pod borer and the pea weevil continued. Of the pod borer parasites, 90 adults and 3,845 cocoons of *Microbracon*

piger (Wesm.), and 6,004 cocoons of *Phanerotoma planifrons* (Nees) were shipped from the European station at St. Cloud, France. In addition, 20,000 field-collected pod borer larvae and 43,000 larvae of the Mediterranean flour moth, parasitized by *Phanerotoma*, were imported and the parasites reared at the receiving station. A total of 19,854 *Phanerotoma* had emerged from this material by the end of June.

The importations of pea weevil-parasite material consisted of 250 pounds of infested horse beans containing approximately 15,000 of the parasite *Triaspis thoracicus* (Curt.).

COOPERATIVE WORK WITH THE PUERTO RICO AGRICULTURAL EXPERIMENT STATION

The cooperative work with Puerto Rico has been continued and the Division arranged, through cooperation of several other divisions of the Bureau and other organizations, for the shipment of parasites and predators to the island, as listed in table 12.

TABLE 12.—*Shipments of parasites into Puerto Rico, fiscal year 1938*

Host	Parasite or predator	Origin	Shipped
			Number
Bamboo scale	*Chilocorus cacti* L.	Cuba	1,086
Do	*C. platycephalus* Muls.	do	912
Horn fly	*Canthon laevis* Drury	United States	9,548
Lima bean pod borer	*Phanerotoma planifrons* (Nees)	Europe	5,000
Sugarcane borer	*Chelonus annulipes* Wesm.	United States	65,800
Yellow sugarcane aphid	*Coelophora inaequalis* F.	Hawaii	395
Do	*Platyomus lividigaster* Muls.	do	100

COOPERATION WITH FOREIGN ORGANIZATIONS

The Division forwarded directly, or through the cooperation of other divisions of the Bureau, shipments of parasites and predators to the countries listed in table 13.

TABLE 13.—*Shipments of parasites and predators to foreign countries, fiscal year 1938*

Country	Host	Parasite
Bahama Islands	Citrus blackfly	*Cryptognatha* sp.
Canary Islands	Mediterranean fruitfly	*Opius tryoni* Cam.
Egypt	do	Do.
Do	do	*Tetrastichus giffardianus* Silv.
Italy	Oriental fruit moth	*Macrocentrus ancylivorus* Roh.
Peru	Codling moth	*Ascogaster quadridentata* Wesm.
Do	Mealybugs	*Cryptolaemus montrouzieri* Muls.
Uruguay	English grain aphid	*Lysiphlebus testaceipes* (Cress.).

CONTROL INVESTIGATIONS

FUMIGATION OF LIVING PLANT PRODUCTS WITH METHYL BROMIDE

Experimental work on the application of methyl bromide as a fumigant was continued. A fumigation house for strawberry plants was designed and constructed which embodied several new features and was used in the application of this treatment to commercial quantities of strawberry plants for Japanese beetle larvae. In the fumigation of nursery stock for the oriental fruit moth complete mortality of the hibernating insect was obtained at doses of 3½ and 4 pounds of methyl bromide per 1,000 cubic feet for 4 hours at 70° F., and these treatments were tested on some 40 different varieties of 9 species of deciduous nursery stock, approximately 2,000 trees in all. The trees were planted in the nursery and only two or three varieties showed damage from the treatment.

Bare rooted nursery stock of evergreen ornamentals was fumigated in partial vacuum, varieties of juniper, *Taxus*, and arborvitae being used with excellent results.

In the fumigation of farm products for the Japanese beetle methods were developed for applying the treatment in refrigerator cars in the field, and potatoes, onions, tomatoes, sweetpotatoes, and a number of other fruits and vegetables were successfully treated in commercial quantities. Approximately 2,500 carloads of potatoes were fumigated and shipped to market with apparently no injury and at considerably less cost than with the method formerly employed for freeing this and other commodities from adult Japanese beetles.

Methods of fumigating sweetpotatoes with methyl bromide for the sweetpotato weevil were developed experimentally, and some commercial lots were fumigated and planted. It was found possible to kill all stages of the sweetpotato weevil in the potato by fumigation at atmospheric pressures without apparent injury to potatoes for planting purposes. Sweetpotato sprouts shipped in quantity can be fumigated without injury and freed from any stages of the sweetpotato weevil which may be present.

PHYSIOLOGY OF INSECTS

Studies on the normal physiology of insects are under way as a basis for understanding the physiological effects of insecticides and to provide a more intelligent approach to the practical problem of more efficient insecticides and insecticidal control of insect pests. A tentative classification of the mature and developmental forms of blood cells in the southern armyworm was made which shows a considerable difference in the blood cells in the various stages of development of the insect.

The innervation of the hearts of three insects was studied. The comparative susceptibility of these insects to the poisonous effects of nicotine is apparently correlated with the development and complexity of the lateral heart nerves. Insects in which the lateral heart nerves are well developed seem to be more susceptible to nicotine than those in which the lateral nerves are only slightly developed or are not present.

Studies on the southern armyworm indicate that the fat body in the insect, which is supposed to be stored food, is increased when the insect is fed glucose. It is indicated that glycogen is formed from glucose, and that this substance is stored as a reserve food material.

The effect on the histology of the alimentary canal of the southern armyworm produced with various insecticides is being studied. As is to be expected, widely divergent effects by the different poisons were evident.

TESTING OF INSECTICIDES

In cooperation with the Bureau of Plant Industry, in connection with breeding or selecting plants having insecticidal properties, some 880 plant extracts were tested on houseflies and mosquito larvae in a biological assay of the insecticidal value of various selected plants. These plants were pyrethrum- or rotenone-bearing plants, in most cases grown in connection with a project for developing strains with higher insecticide content. Eight hundred and ninety-eight materials were tested on insect pests which feed on the leaves of crop plants. Of these materials, 729 were synthetic organic chemicals and 169 were of plant origin. Seventeen of the materials caused 100-percent mortality in the test insects, which were well-grown specimens of the southern armyworm, while a much larger number caused complete mortality in Colorado potato beetle larvae. Five other insects of economic importance as pests of crop plants were used in tests, and certain of the compounds were tested for their effect on the crop plants.

STUDIES ON NICOTINE FUMIGATION

The results of experimental work on nicotine fumigation show that its efficiency depends on the concentration of the nicotine and the length of exposure, the former being much more important in influencing effectiveness. On certain insects, including the bean and chrysanthemum aphids, the onion thrips, and the American cockroach, nicotine was apparently much more toxic than hydrocyanic acid.

In greenhouse fumigation a method of atomizing nicotine and distributing it throughout the greenhouse was found considerably more effective than the old

tobacco-vapor-smudge method. Vaporization of nicotine in the exhaust pipe of a gasoline engine also gave high concentrations which were effective. Dry conditions in the greenhouse result in somewhat higher concentrations of nicotine, with an increase in insecticidal efficiency with the same dosage.

Atomization of nicotine and its application under canvas trailers was found effective against spinach and pea aphids in the field.

APPLICATION OF INSECTICIDES

Experimental work was continued on methods of applying insecticides from the upper air in the form of dust or dust mixed with adhesive, and a mechanical apparatus was developed for such application, constructed, and mounted in a rotary-winged aircraft. It will be given practical commercial tests in the near future. Various modifications were made in the apparatus for spraying for the gypsy moth, including the redesigning and remodeling of spray equipment for the application of wet insecticides.

INSECTICIDE INVESTIGATIONS

The Division of Insecticide Investigations continued work on all its projects designed to develop new and more effective insecticides. The general work was performed in Washington, D. C., and more specific problems were studied at the six field stations maintained by the Division. Many of the results were made available to the public through the medium of 52 scientific articles, of which 7 appeared in Department publications and the rest in outside journals. Seventeen patents, of which 13 describe new synthetic organic insecticides, were issued to members of the Division, and the monthly review of United States patents relating to pest control was, as usual, issued regularly and distributed to a large list of entomologists, both American and foreign.

CHEMICAL INVESTIGATIONS ON INSECTICIDAL PLANTS (TOBACCO, DERRIS, PYRETHRUM, ETC.) AND THEIR CONSTITUENTS

The study of the constitution of the pyrethrins, which are the active constituents of the very important group of insecticidal preparations made from pyrethrum flowers, was actively continued. Much knowledge of the structure of the side chain was gained, but its exact nature has not yet been determined. Further attempts to obtain the two pyrethrins separately and in pure condition were made with a newly available solvent, and by means of selective adsorption on various powders, but these attempts were unsuccessful. Three scientific articles dealing with the chemistry of the pyrethrins and one concerning their relative toxicity to flies were published.

Different species of *Nicotiana* now commercially unknown and their hybrids with tobacco (*N. tabacum*) were examined for their content of alkaloids. The presence of nornicotine was noted in *N. trigonophylla* and in various hybrids of *sylvestris*×*tabacum*. In addition to nornicotine, *N. trigonophylla* was found to contain a new alkaloid whose nature is not yet fully determined. A new sample of *N. glauca* and several of its hybrids with *N. tabacum* were shown to contain anabasine with small proportions of nicotine. One article concerning certain phases of this work was published.

The study of rotenone-bearing plants was confined to work with derris and cube, which, however, covered several aspects. Upon conclusion of the work on the development of analytical methods, descriptions of the procedures adopted both for extraction of the rotenone and for its recovery from the extract were published, and steps were taken to have them adopted by the Association of Official Agricultural Chemists, an action which will make them the standard methods of the Department. A study was begun of the alkaloidal material occurring in some samples of cube to the extent of 0.1 to 0.2 percent and in derris in lesser amounts, but no information as to its nature is yet available. An investigation was also made of the soluble constituents of derris root in an effort to learn more about the toxicity of this important insecticide to warm-blooded animals. These water-soluble constituents have now been shown to be nontoxic to mice. They contain a large quantity of some sugar, but the absence of a toxic glucoside has been proved.

The study of the constituents of quassia wood was continued, and comparative experiments were made with the four isomers that have been named quassin, neoquassin, picrasmin, and isoquassin. Although their structures have not been fully determined, some progress was made and a report of accom-

plishments will soon be published. Certain species of *Helenium* were also investigated. The results concerning tenulin, a compound present in *H. badium*, will soon be published.

Other plants to which some attention was devoted include *Phellodendron amurense*, *P. lavalli*, *Sapindus drummondi*, and *Madhuca latifolia* or Mowrah meal. The last-named material was found to contain a large quantity of a saponin, which is probably the constituent responsible for the toxicity.

CHEMICAL INVESTIGATIONS TO DEVELOP SYNTHETIC ORGANIC INSECTICIDES

The search for organic compounds capable of being substituted for lead arsenate and other harmful metallic poisons was continued vigorously. Approximately 200 compounds were obtained or synthesized, and submitted to cooperating entomologists for testing against various insects. Three such materials, namely, dibenzothiophene, thiocoumarin, and phenothioxin, were considered of sufficient promise to be applied in small field tests against the codling moth at Vincennes, Ind., but the results of these tests are not yet available.

Phenothiazine continues to hold interest as a possible means of control for codling moth larvae and other insects. Chemical work with it, however, was confined to the determination of residues and an attempt, described later, to find stickers to improve its adherency to foliage. Incidentally, when samples of markedly different degrees of fineness were prepared, it was found by entomologists that their toxic effects on codling moth larvae were radically different, the finest material being the most effective.

Thirteen patents covering the use of various compounds as insecticides were issued to members of the Division.

CHEMICAL INVESTIGATIONS ON THE REMOVAL OF SPRAY RESIDUE

Studies on the removal of spray residues were carried on both in Washington, D. C., and at the field stations in Yakima, Wash., and Vincennes, Ind. It was found that the use of bordeaux mixture increases the difficulty of removing lead arsenate from apples, that there is a varietal effect, and that variations in picking date are relatively unimportant.

A detailed study of derris residues on cabbages was made. The analyses were made by the colorimetric procedure previously developed in this Division. It was demonstrated that the heaviest treatment used left a residue of 0.22 grain per pound, which is less than one-tenth of the quantity reported to have been fed to experimental animals without deleterious effect. No studies of washing technique were made, but analyses made before and after rain indicate that about 90 percent of the residue is easily washed off.

CHEMICAL INVESTIGATIONS TO DEVELOP INORGANIC INSECTICIDES

Because of its importance for the control of the cotton boll weevil, considerable attention was again given to calcium arsenate. One sample was put through an air classifier, and detailed physical and chemical analyses made of the fractions obtained. It was found that, not only was a physical separation into different particle-size ranges accomplished, but there was also a very evident chemical fractionation. The free lime and the basic arsenates accumulated in the finer fractions, with the result that the soluble-arsenic content was greatly different in the various portions. Similar separations were then made on the three types of commercial product undergoing tests in the Division of Cotton Insect Investigations, but the chemical analyses have not yet been made. Some of the fractionated samples were referred to various entomologists for accurate study of their relative toxicities, as part of a general investigation of the relation of particle size to insecticidal effectiveness now being conducted by the Division. Included in this study are samples of lead arsenate and of cryolite prepared to have different average particle sizes, and preliminary reports indicate that, at least for some methods of testing, particle size is of paramount importance.

A study was made of the variation in deposits of lead arsenate among the apple plugs used by one entomologist in testing relative toxicity. A determination was made of the particle-size distribution of all lead arsenates on the market, and fractions of different average particle size were prepared for inclusion in the study of size in relation to toxicity. In connection with the Japanese beetle work effort was continued to develop a chemical method of

estimating the effectiveness of a treated soil, and a greatly enlarged program of testing limonite as a means of correcting damage to soil caused by lead arsenate was started.

CHEMICAL INVESTIGATIONS ON FUMIGANTS FOR CONTROL OF INSECT PESTS

As for several years past, the work on fumigation dealt principally with two subjects, the chemical phases of the control of grain insects at Manhattan, Kans., and the problem of resistant California red scale on citrus at Whittier, Calif.

The work on grain-insect fumigation consisted of studies of the distribution of the fumigants during use and of their retention by the fumigated products. It was found that fumigated rice retains hydrocyanic acid for several days, suggesting that only short exposures may be necessary since the adsorbed fumigant is probably capable of exercising its toxic action over long periods. In conjunction with cooperating entomologists, a device was developed for spraying hydrocyanic acid onto a stream of rice flowing into a bin, and it is hoped that the thorough distribution of this fumigant found by chemical analysis will result in satisfactory insect mortality.

Practically all the work at the Whittier, Calif., station was directed to conducting the large number of experimental hydrocyanic acid fumigations of various stages of the resistant red scale necessary to assist the entomologists in improving their technique to the point where they can be sure that differences found are of real value. Attempts were made to correlate the large differences often found in apparently uniform experiments with conditions of the host lemons, character of the "reservoir" lemons on which the insects are reared, age of the insects, population density, and various other factors.

Three other fumigation problems came in for some study. A large number of nicotine analyses were made for one of the cooperating entomologists who has been studying the dosage-mortality responses of aphids to nicotine vapor, the work leading to a publication describing the fumigation apparatus used. The attempt to find a satisfactory method for determining methyl bromide in vegetable products fumigated with it was continued. A study of the control of stinking smut of wheat by means of gaseous chlorine resulted in the devising of apparatus suitable for controlled experimental treatments.

CHEMICAL INVESTIGATIONS ON ACCESSORY MATERIALS FOR USE WITH INSECTICIDES

The work with accessory materials dealt both with the investigation and intercomparison of wetting and spreading agents in general and with attempts to develop wetters and adhesives for specific insecticides, notably phenothiazine and nicotine peat. The information obtained concerning the wetting and spreading properties of soap solutions made by combining sodium hydroxide and sodium carbonate with *n*-caproic, *n*-caprylic, *n*-capric, lauric, myristic, and palmitic acids was incorporated in two manuscripts, one of which was published, as was another dealing with triethanolamine oleate. The spreading coefficients of 81 additional proprietary detergents, wetting agents, and emulsifying agents were determined and the list published.

It is well established that deposits of phenothiazine heavy enough to be insecticidally sufficient for codling moth control can easily be obtained in the apple orchard; but its adherency is far from satisfactory. Efforts to develop adhesives were made at the Yakima, Wash., Vincennes, Ind., and Beltsville, Md., stations. At Yakima various plastics were tried but proved incompatible. Propylene glycol showed some promise, and kerosene gave good deposits unaccompanied by any injury. At Vincennes rosin residue and calcium soap both showed some promise, but in the case of the calcium soap there was a suggestion of decreased insecticidal effect. Various copper and sulphur fungicides proved of little use. At Beltsville the search for a suitable sticker was made part of a general investigation in which a large number of dispersing agents were first studied and then a few studied more closely. It was found that phenothiazine is probably less stable in the presence of stickers.

Efforts to develop adhesives for nicotine peat at Vincennes proved fruitless. Bentonite appeared to have some value, but probably only because of its own well-known nicotine-holding power.

TESTS TO DETERMINE THE TOXICITY OF NEW INSECTICIDAL COMPOUNDS TO GOLDFISH

The study of the relationship between chemical structure of organic compounds and their toxicity, as revealed by tests with goldfish, was continued with two groups of compounds, the nitrophenols and the halogenated phenols. According to the criterion now used for judging comparative toxicities, orthonitrophenol is the least toxic of the three nitro compounds, being slightly less toxic than the parent compound, phenol. The metanitrophenol is nearly twice as toxic and the para compound about five times as toxic as phenol. Among the halogenated phenols, the chloro and bromo compounds as groups do not differ much, but the iodophenols are appreciably more toxic. In each group the para isomer is the most toxic.

ANALYTICAL INVESTIGATIONS

About 500 routine samples of insecticidal materials submitted by other Divisions of the Bureau were analyzed. In addition, a great deal of investigative work on the improvement of old analytical methods and the development of new ones was conducted.

The adaptation of a blue colorimetric microchemical test for silicon to the determination of fluorine residues was attempted. Distillation carried over fluorine in fixed proportion to silica, and good results were obtained with sodium fluoride and sodium fluosilicate, and the study of the method is being continued.

Significant progress was made in the methods for determining small quantities of arsenic. A digestion procedure using perchloric acid capable of recovering the arsenic from otherwise intractable organic substances was developed, the general unsatisfactory nature of the Gutzeit method was demonstrated by showing that the quantity of mercury laid down in the paper strip used is variable with the best recommended technique of impregnation, and three new procedures to replace the Gutzeit method were devised. One of these, involving isolation of the arsenic by evolution in the form of arsine and absorption in a mercuric chloride solution, followed by colorimetric determination as the blue molybdate compound in a photometer, appears excellent, since it extends the range normally covered by the Gutzeit method to both appreciably smaller and larger quantities. The colorimetric procedure previously developed in this Division for the estimation of phenothiazine deposits was given considerable attention. Some of its limitations, due primarily to easy decomposition, have been recognized, and changes made to circumvent them to some degree.

A possible new method for the estimation of each of the two pyrethrins in pyrethrum powder, based on cleavage of these compounds by hydrogenation to form determinable acids, was devised, the work on the commonly used method of determining rotenone and total extract in derris and cube was brought to a conclusion preparatory to its adoption as the official method of the Department, a new volumetric procedure capable of shortening one of the gravimetric steps in this method was worked out, and a study of the problem of distinguishing derris from cube by microscopical examination or colorimetric chemical tests was started. Two new microchemical methods for nicotine were also developed; one uses brucine to permit the recovery of nicotine from residues of nicotine bentonite, and the other makes use of the pink color developed with cyanogen bromide and α-naphthylamine, which is sensitive enough to permit estimation of the nicotine on an individual apple.

TRANSIT INSPECTION

Inspection activities carried on last year at 18 of the more important railway centers of the United States were extended this year to 3 additional stations. Shipping of nursery stock during the last spring and fall was observed to be considerably in excess of that of the previous year. During the year 1,412,824 shipments of mail, express, and freight were inspected in transit for compliance with Federal domestic plant quarantines, and 4,070 violations were intercepted as compared with 2,678 in 1937. In addition to the regular inspection activities with reference to Federal domestic quarantines, there were noted by transit inspectors, and reported to enforcing organizations, 188 apparent violations of intrastate quarantines relating to pests on account of which Federal quarantines have been established, 50 apparent violations

of the Insect Pest Act, approximately 600 apparent violations of the postal regulation concerning State nursery certification, and many other apparent infringements of State nursery inspection regulations.

The regular force of 17 inspectors was assisted, in periods of heavy shipping, by 15 to 20 inspectors from other projects of the Bureau and by 6 to 9 State inspectors. The assignment of inspectors from the cooperating projects at Boston and New York during the Christmas season resulted in increased interceptions of Christmas trees and evergreen cuttings, including apparently wilful violations of the gypsy moth quarantine.

Table 14 gives data pertaining to shipments intercepted at transit inspection points.

TABLE 14.—*Shipments of nursery stock and other articles intercepted in violation of Federal plant quarantines at transit inspection points, fiscal year 1938*

Station	Shipments intercepted in apparent violation of quarantines relating to—								
	Black stem rust	Gypsy moth and brown-tail moth	Japanese beetle	Pink bollworm	Thurberia weevil	White-pine blister rust	Mexican fruitworm	Dutch elm disease	Total
Atlanta		1	48				7		56
Boston		488	255			4			747
Buffalo			12						12
Chicago	1	79	199	1	1	17	57		355
Cincinnati		4	27	3		3	39		76
Cleveland		3	3				1		7
Columbus, Ohio							1		1
Dallas			1	3			18		22
Detroit		45	9						54
Indianapolis		1					2		3
Jacksonville		12	110						122
Kansas City		14	89	4	3	2	90		202
Memphis		1	1	2		2	14		20
New York		428	687			13		1	1,129
Omaha		24	168			8	6		206
Philadelphia		42	177			9	18		246
Pittsburgh	1	10	345			6	45		407
St. Louis		6	50			3	134		193
St. Paul		1	2				4		7
Springfield, Mass		127	37						164
Washington, D. C		8	31			2			41
Total	2	1,294	2,251	13	4	69	436	1	[1] 4,070

[1] The total number of violations represents 3,975 shipments, of which 87 were in violation of 2 quarantines and 4 were in violation of 3 quarantines.

TERMINAL INSPECTION OF MAIL SHIPMENTS

The States of Arkansas and Oregon have availed themselves of the provisions for enforcing certain State quarantines through postal channels, as provided in the amendment (act No. 643 of June 4, 1936) to the law relating to terminal inspection of mail shipments of plants and plant products.

The terminal-inspection procedure which has been in effect for several years, and which provides for turning back or disinfecting mail shipments of plants and plant products if found infested, is continued in Arizona, California, the District of Columbia, Florida, Hawaii, Idaho, Louisiana, Mississippi, Montana, Oklahoma, Oregon, Puerto Rico, Utah, and Washington.

CONVICTIONS AND PENALTIES IMPOSED FOR VIOLATIONS OF THE PLANT QUARANTINE ACT

The following convictions and penalties imposed for violations of the Plant Quarantine Act were reported to the Bureau:

Gypsy moth and brown-tail moth quarantine: One conviction, with fine of $25.

Japanese beetle quarantine: Twenty convictions, with fines aggregating $600.

White-pine blister rust quarantine: One conviction, with fine of $130.

Quarantines affecting Mexican plants and plant products: Fines aggregating $414.40 were imposed by customs officials on the Mexican border against 310 persons caught attempting to smuggle in from Mexico prohibited plants and plant products.

FOREIGN PLANT QUARANTINES

The Division of Foreign Plant Quarantines is engaged in the enforcement of quarantines and regulatory orders of the Department prohibiting or restricting the entry of various plants and plant products entering the United States, the maintenance of a certification service to inspect and certify plants and plant products to meet the sanitary requirements of foreign countries, and, in addition, the enforcement of such domestic quarantines as affect the movement of plant material between the Territories of Hawaii and Puerto Rico and continental United States.

Plant-quarantine inspectors and collaborators are stationed at the more important ports of entry and at points distributing foreign mail, and work in close cooperation with employees of the Treasury and Post Office Departments.

The rules and regulations covering the importation of cotton and cotton wrappings into the United States were modified, effective December 11, 1937, to permit the movement of cotton from one approved customs port where plant-quarantine requirements can be met to another for fumigation.

MARITIME PORT INSPECTION

SHIP INSPECTION

Ships from foreign countries and also those from Hawaii and Puerto Rico and the coastwise ships that pass through the Panama Canal are inspected promptly on arrival for the presence of prohibited and restricted plant material in passengers' and crews' baggage, ships' stores, quarters, and cargo.

The inspection at ports in California, Florida, and Hawaii and at certain ports in Puerto Rico has been performed by State and Territorial officials serving as collaborators of the Bureau.

A record by ports of the ship inspection appears in table 15.

TABLE 15.—*Number of ships inspected, fiscal year 1938*

Port	From foreign ports											
	Direct			Via United States ports			Via Hawaii			Via Puerto Rico		
	Arrived	Inspected	With prohibited material	Arrived	Inspected	With prohibited material	Arrived	Inspected	With prohibited material	Arrived	Inspected	With prohibited material
Baltimore	739	738	303	908	897	431						
Bellingham	36	36	8									
Boston	1,224	1,219	540	360	359	158						
Brownsville	3	3	3	6	6	3						
Brunswick [1]	2	2	1									
Buffalo	7	7	6									
Charleston	188	188	88	174	169	67				1	1	0
Chicago	12	12	6									
Detroit	22	22	14									
Eureka [2]	2	2	1	9	9	2	1	1	0			
Galveston	516	516	327	518	517	286				3	3	2
Guam	25	22	11	2	2	0						
Gulfport [3]	16	15	13	103	26	15						
Honolulu [2]	235	235	106	6	6	0						
Houston	520	519	413	459	451	253						
Jacksonville [2]	243	243	23	122	122	0				2	2	0
Key West [2]	153	145	75	30	25	2						
Miami [2]	1,435	1,434	443	28	28	15				2	2	1
Mobile	309	309	134	405	387	171						
New Orleans	1,445	1,444	797	470	470	301	1	1	1			
Newport News	105	105	74	349	345	157						
New York	3,681	3,644	2,075	1,033	921	458				125	125	85
Norfolk	336	336	185	748	747	354				1	1	0
Pensacola [2]	46	46	20	181	181	78						
Philadelphia	737	737	356	1,101	1,089	604						
Port Arthur	478	478	384	318	318	132						
Portland, Oreg	104	104	81	323	301	183	1	1	1			
Port San Luis [2]	71	71	46				1	1	0			
Puerto Rico (all ports)	1,077	1,070	302									
San Diego [2]	1,273	1,272	53	18	18	4						
San Francisco [2]	358	358	229	760	760	346	92	92	62			
San Pedro [2]	1,479	1,476	900	462	460	176	64	64	35	7	7	5
Savannah	126	126	77	197	197	107						
Seattle	1,159	1,040	245	248	248	161	2	2	2			
Tampa [2]	292	292	109	308	308	92						
Ventura [2]	3	3	0									
West Palm Beach [2]	167	167	6	10	10	0						
Total	18,624	18,436	8,454	9,656	9,377	4,556	162	162	101	141	141	93

TABLE 15.—*Number of ships inspected, fiscal year 1938*—Continued

Port	From Hawaii						From Puerto Rico						From United States ports		
	Direct			Via United States ports			Direct			Via United States ports			Via Panama Canal		
	Arrived	Inspected	With prohibited material	Arrived	Inspected	With prohibited material	Arrived	Inspected	With prohibited material	Arrived	Inspected	With prohibited material	Arrived	Inspected	With prohibited material
Baltimore	1	1	1	51	51	0	7	7	0	23	23	0	223	222	2
Bellingham	1	1	1												
Boston	1	1	0	16	16	0	17	17	0				206	206	1
Charleston							3	3	0	21	21	1	28	28	0
Eureka [2]				7	7	0							2	2	0
Galveston				5	5	1	10	10	1	7	7	1	13	13	0
Guam	12	11	9												
Gulfport [3]										10	2	0			
Honolulu [2]													98	98	0
Houston	3	3	0	3	3	0	6	6	0	8	8	0	51	51	0
Jacksonville [2]							22	22	0	5	5	0	16	16	1
Miami [2]							1	1	0						
Mobile	3	3	1	7	7	0	29	29	3	52	48	0	72	72	0
New Orleans	5	4	2	12	12	2	24	24	3	52	52	2	65	65	6
Newport News							2	2	0	5	5	0	9	9	0
New York	15	15	2	48	40	2	103	100	17	9	6	1	302	255	1
Norfolk							14	14	1	39	38	1	110	110	2
Pensacola [2]							1	1	0	6	6	0			
Philadelphia	1	1	1	35	34	0	36	36	8	13	13	2	315	308	2
Port Arthur							14	14	2	10	10	0	21	21	1
Portland, Oreg	1	1	0	10	10	0									
Port San Luis [2]	12	12	1										1	1	0
Puerto Rico (all ports)													6	6	1
San Diego [2]	86	86	8	1	1	0							152	151	6
San Francisco [2]	182	182	34	30	30	2							584	584	13
San Pedro [2]	124	124	25	53	53	7	1	1	1				776	773	115
Savannah				2	2	0	17	17	1	18	18	0	21	21	1
Seattle	9	8	2	5	2	1									
Tampa [2]							24	24	2	2	2	0			
Ventura [2]	4	4	1												
Total	460	457	88	285	273	15	331	328	39	280	264	8	3,071	3,012	152

[1] Work handled by inspector stationed at Savannah, Ga. [2] Collaborators stationed at these ports. [3] Work handled by inspectors stationed at Mobile, Ala.

Note: The foreign ship arrivals do not in all cases agree with customs figures. Foreign ships may put in for bunkers and be inspected by inspectors of the Bureau of Entomology and Plant Quarantine but not entered by customs. On the other hand, ships entered at certain small subports are included in customs records but not in this report.

CARGO INSPECTION

All importations of plants and plant products subject to plant-quarantine restrictions are inspected at the port of entry or at the port of first arrival. The table pertaining to cargo inspection (table 16) has been enlarged somewhat and includes, in addition to the number of lots of plant material inspected at each port, information on the amounts of the various classes of commodities imported.

TABLE 16.—*Summary of importations of plants and plant products inspected, fiscal year 1938*

Port	Fruits and vegetables			Nursery stock and seeds			Bagging, cotton, cotton products			Bagasse, broomcorn, corn, rice fiber, etc.		
	Lots	Containers	Additional quantities	Lots	Containers	Additional quantities	Lots	Bales	Additional quantities	Lots	Bushels	Additional quantities
Baltimore	233	273	4,598,134 bunches, 99,758 pounds.	189	7,149	3,363 pounds	19	1,379	2,891,000 pounds	8	838,246	
Bellingham	18		6,185 bunches	43	8,923	7 trucks				2	70,531	
Blaine	7	276	1,050 bushels	71	630	100 units, 882 pounds	1	1				
Blaine, for export				6	9							
Boston	319	78,116	3,685,744 bunches	127	2,424	2,245 pounds	1,036	65,465	14,898 bags, 420 packages.	17	1,373,386	1,227 bales.
Boston, for export							11	1,015		7		2,602 bales.
Brownsville	617	11,133	17,317 pounds, 74,322 bunches.	4	700	1 pound	10		952,990 pounds	15	51	14 bales.
Brownsville, for export							55	3,016	3,043,744 pounds			
Buffalo	42	1,327		78	85	4,676 pounds	31	1,074	5 packages	111	4,075,870	
Calexico	34	1,537	29,626 pounds				404	63,210	12,339,016 pounds			
Calexico, for export	3	22	54,420 pounds				1		55 pounds			
Charleston	134		1,508,745 bunches	1	150		34	3,551				
Chicago	27	21,496		3	85		3	14		103	11,024,202	4 bales, 4 cases.
Del Rio	31	53										
Detroit	31	11,612		221	1,151	1,419 units, 15 pounds.	211	6,600		12	2,333	3 cases.
Douglas	1									12	38	
Eagle Pass	574	18,413	6,561 bushels							4		83 bales.
El Paso	4,183	72,449	2,426,383 pounds, 1,702,696 bunches.	7	16	3 units	29	704	155,238 pounds, 7 packages, 11 cans.	3	1,268	
El Paso, for export	7	21		8	12		1	1		12	79	
Galveston	168	1,919	3,474,790 bunches, 5,436 fruits.	1	36		153	53,856				
Gulfport [1]							5	460				
Hidalgo	295	388					2		4 bags	6	6	2 bags.
Honolulu [2]	633	5,253		126	308	44 pounds				24	195	5 bags.
Honolulu, for export	6	45								2		21 bags.
Houston				5	422		216	65,797		1	255,000	
Jacksonville [2]	175	60,671	1,982,892 bunches	2	4					7	107,307	
Jacksonville, for export	40	11,950										
Key West [2]	478	30,370	84 fruits, 2,185 bunches.									
Laredo	2,370	315,653	1,462,510 bunches	1	1							
Mercedes										10	27	
Miami [2]	1,083	721,818	396,919 bunches, 2,953 fruits.	12		303 pounds				3	17	
Mobile	155	288	3,703,211 bunches, 2,000 pounds.	24	24,868		48	11,982		15	577,139	
Naco, for export							1		284 units	1		2 units.

New Orleans	1,655	293,485	15,143,787 bunches, 284,720 pounds, 120 fruits.	36	27,552		123	29,000	1 package	27	1,901,457	
New Orleans, for export	95	30,869		1	1							
Newport News	1	3,200		5	300							
New York	9,947	3,829,908	11,930,078 bunches, 290 pounds, 6,992 fruits.	1,534	78,655	44,091 pounds	986	158,008	493 packages	148	2,896,889	680 miscellaneous containers, 1,571 bales.
New York, for export	850	338,041		73	623		563	65,196	38,637 bags, 243 packages.	36	12,096	5,053 bales, 130 bags, 25 miscellaneous containers.
Niagara Falls [3]	226	3,538		253	134	14,075 units	171	2,535	508 bundles, 31 bags	2	2	
Nogales	3,146	1,458,211	7,619 fruits, 390 bunches, 88 pounds	6	12	339 units				3	2,368	300 dozen.
Norfolk	66		496,893 bunches	28	2,908		89	12,175		2	43,491	
Pensacola [2]	3		23,302 bunches									
Philadelphia	167	18,238	5,017,992 bunches	106	9,977	1,429 pounds	67	5,926		19	1,045,271	
Philadelphia, for export				1	7		1	60				
Port Huron [2]	21	3,677	2,025 bunches	34	96	92 units, 200 pounds						
Portland	3	25,078		30	1,396	2,800 pounds	12	1,338	6,000 bags	15	655,270	
Presidio	1	1								2	1	4 bags.
Providence [4]	1		16,696 bunches				17	2,814				
Puerto Rico	336	69,126	42 bunches	73	76	2,660 pounds, 262 units.	1		556 bags	269	360,166	33 bales.
Puerto Rico, for export	4	1,214								11	540	
Roma										1		1 bundle.
St. Paul							6	42				
San Diego [2]	4	25	26,246 bunches									
San Francisco [2]	1,424	23,615	1,772,507 bunches	443	4,652	16,038 pounds	95	7,699	7,000 bags, 6 packages.	17	1,360,063	
San Francisco, for export.	13	17	670 bunches	7	73		5	313				
San Pedro [2]	306	18,507	1,835,003 bunches	79	2,230	15,071 pounds	71	9,891	2,000 bags, 4 packages.	34	1,164,894	
San Pedro, for export				5	15		1	100				
San Ysidro	61	1,759		8		168 units				1		6 bags.
San Ysidro, for export	17	11,334										
Sault Ste. Marie [5]	11	15	2,035 bunches							1		3 bags.
Savannah	15		76,954 bunches	9	2,203		33	4,149	2,023 bales			
Seattle	398	120,920	499,393 bunches	373	61,739	14,804 pounds, 1,406 units.	41	3,387	56 bundles	32	1,239,147	
Seattle, for export	5	18		20	1,761		5	306				
Tampa [2]	1,458	99,223	654,985 bunches, 305 fruits.							3	84,963	
Total	31,898			4,053			4,558			998		
Total all lots, 41,485.												

[1] Work handled by inspectors stationed at Mobile.
[2] Collaborators stationed at these ports.
[3] Work handled by inspector stationed at Buffalo.
[4] Work handled by inspector stationed at Boston.
[5] Handled through customs.

In addition to the above, 1,777 lots of plant material were entered at Canadian border ports where no plant-quarantine inspectors are stationed, through the cooperation of the customs officers and of the Division of Foreign Pests Suppression of the Canadian Department of Agriculture. This material consisted of 21 lots representing 2,335 bunches of bananas and 630 containers of other fresh fruits and vegetables not of Canadian origin; 404 lots consisting of 10,627 bales of bagging, cotton, and cotton products; 454 lots totaling 4,113,912 bushels of corn; and 177 lots consisting of 898 containers and 600 individual plants entering under regulation 15 of Quarantine No. 37.

In addition to the importations credited to the Mexican border ports, there were several thousand importations of permitted fruits and vegetables in such small quantities that no entries were required by customs and no records of them have been kept. All these small importations were carefully inspected before being released and, taken as a whole, they represent a very considerable amount of work, especially at the larger ports.

At many of the ports considerable time was devoted to the inspection of packing materials used with various commodities to determine compliance with Quarantine No. 69. As a result of such inspection many interceptions of prohibited packing material were made. The straw jackets on many shipments of imported liquors were found to be contaminated with vetch plants bearing seed infested with living bruchids. All jackets in which living bruchids were found were required to be removed and destroyed or given the fumigation approved for imported vetch seed found to be infested with living bruchids.

DISINFECTION

Disinfection is required of certain commodities as a condition of entry and of other commodities when inspection reveals the presence of injurious insects or plant diseases. The following plant material was treated under the supervision of inspectors and collaborators of this Bureau:

Cotton	bales	141,791
Cotton waste	do	16,992
Cotton linters	do	10,107
Cotton samples	packages	793
Cottonseed fiber	bales	1,301
Bagging	do	7,516
Broomcorn	do	1,173
Rice fiber	do	405
Vetch	bags	4,873
Tree seeds	lots	56
Miscellaneous plants	do	837
Narcissus	cases	7,484
Chestnuts	do	5,616
Cipollino	do	3,697
Acorns	do	20

In addition to the foregoing, various shipments of plant material and cotton samples were treated at the inspection house in Washington, D. C., as shown in table 19.

AIRPLANE INSPECTION

There was a marked increase in the number of airplanes inspected compared with the preceding year. A total of 4,262 airplanes were inspected, representing an increase of 941, or 28 percent. Airplane inspections were made at the following 19 ports of entry. Douglas and Nogales, Ariz.; Calexico, Los Angeles, San Diego, and San Francisco, Calif.; Key West, Miami, Pensacola, and West Palm Beach, Fla.; Agana, Guam; Honolulu, T. H.; Baltimore, Md.; New York, N. Y.; San Juan, P. R.; Brownsville, El Paso, and Laredo, Tex.; and Seattle, Wash. As a result of these inspections 998 interceptions of prohibited and 233 interceptions of restricted plant material were taken from 998 airplanes.

FOREIGN PARCEL-POST INSPECTION

Through cooperation with customs and post-office officials, foreign mail packages found to contain plants or plant products are referred to inspectors of this Bureau for examination. Such packages arriving at ports of entry where no plant-quarantine inspectors are stationed are forwarded to the nearest port where inspection can be made.

A record by port of the number and disposition of foreign parcel-post packages inspected appears in table 17.

TABLE 17.—*Foreign parcel-post packages inspected, fiscal year 1938*

Port	Inspected	Refused entry (entire or in part)	Diverted to Washington	Released under permit	Port	Inspected	Refused entry (entire or in part)	Diverted to Washington	Released under permit
Atlanta [1] [2]	12	1	8	1	Miami [1]	147	22	71	3
Baltimore	1,361	26	131	74	New Orleans [6]	231	13	79	13
Boston	6,082	116	751	98	New York	166,644	587	5,549	399
Brownsville	1,005	2	1	0	Nogales [6]	520	10	8	3
Buffalo	1,622	18	423	32	Philadelphia	8,080	134	671	133
Chicago	12,919	239	446	144	Portland [7]	677	23	0	31
Detroit	4,817	99	126	166	Puerto Rico (all ports)	26	5	0	14
Eagle Pass	275	0	0	0	St. Paul	15,134	56	68	65
El Paso [3]	462	25	32	3	San Diego [1]	80	4	0	14
Galveston	7	0	7	0	San Francisco [1]	6,415	92	7	759
Guam	103	0	0	0	Seattle	1,583	50	3	295
Honolulu [1]	1,719	149	0	148	Tampa [1]	10	3	2	0
Houston [4]	171	5	18	0	Washington	1,696	23	0	539
Jacksonville [1]	96	5	12	8					
Key West [1]	5	0	0	0	Total	236,245	1,817	8,448	2,995
Laredo	394	48	26	2					
Los Angeles [1] [5]	3,952	62	9	51					

[1] Collaborators are stationed at these ports.
[2] Opened Jan. 8, 1938.
[3] 3 packages were diverted to San Francisco for disposition.
[4] 145 packages (cotton samples) were diverted to Brownsville for fumigation.
[5] 95 packages were diverted to San Francisco for disposition.
[6] 1 package was diverted to San Francisco for disposition.
[7] 14 packages were diverted to Seattle for disposition.

It has been the policy for a number of years to admit shamrocks through the mails provided they are free from soil. Large numbers are brought in in this manner each year and they have been included in table 17. Of the number of packages listed as inspected, the following represent shamrocks: Baltimore, 48; Boston, 1,696; Buffalo, 18; Chicago, 3,653; Detroit, 203; Los Angeles, 96; New York, 92,900; Philadelphia, 1,308; St. Paul, 469; San Francisco, 241; Seattle, 203.

MEXICAN-BORDER SERVICE

The increase in travel between Mexico and the United States noted in the last annual report continued through the year. Practically all activities at Mexican border ports showed gains. The number of freight cars entering from Mexico increased from 32,050 in 1937 to 35,141 in 1938. The car fumigations increased from 8,226 to 9,953. Cars to the number of 2,874 were found contaminated with cottonseed this year whereas the total found contaminated last year was 2,034. All cars found contaminated with cottonseed were required to be clean before entry was permitted. The usual fee of $4 was charged for each car fumigated, and all fees collected were covered into the Treasury as miscellaneous receipts.

A summary of the railway-car inspection and fumigation is shown in table 18.

TABLE 18.—*Inspection and fumigation of railway cars crossing the border from Mexico, fiscal year 1938*

Port	Cars inspected	Cars with cottonseed	Cars entered	Cars fumigated	Fees collected	Port	Cars inspected	Cars with cottonseed	Cars entered	Cars fumigated	Fees collected
	Number	*Number*	*Number*	*Number*	*Dollars*		*Number*	*Number*	*Number*	*Number*	*Dollars*
Brownsville	493	1	490	45	188	Naco	652	5	652	1	4
Douglas	1,913	6	1,913	64	256	Nogales	5,772	200	5,587	1,418	5,800
Eagle Pass	2,306	162	2,219	839	3,400	Presidio	324	29	315	83	336
El Paso	11,150	228	10,658	[1] 1,668	6,528						
Laredo	15,067	2,243	13,307	5,835	22,600	Total	37,677	2,874	35,141	9,953	[2] 39,112

[1] Includes 6 cars not from Mexico.
[2] The apparent discrepancy in fees collected and the number of cars fumigated may be explained by the fact that it is customary for the railroads to purchase fumigation coupons in advance.

In addition to the freight cars listed in table 18, 4,839 pullman and passenger coaches entered and were inspected at the following ports: El Paso, 1,199; Laredo, 3,121; Nogales, 517; and Presidio, 2.

Plant-quarantine inspectors at Mexican border ports, in cooperation with the customs service, devote much time to the inspection of vehicles, baggage, personal effects, and express packages from Mexico.

A total of 336,695 pieces of baggage and 3,876,192 vehicles were inspected. Large quantities of prohibited and restricted plant material were intercepted as a result of these inspections. A record of these interceptions appears in table 21.

INSPECTION IN PUERTO RICO AND HAWAII

Plant-quarantine inspectors stationed in Puerto Rico enforce the provisions of Quarantine No. 58, governing the movement of fresh fruits and vegetables to the mainland, in addition to the enforcement of foreign plant quarantines and regulations as they affect the entry of foreign plants and plant products into the island. Valuable assistance is rendered by insular inspectors serving as collaborators, especially in that portion of the work pertaining to the enforcement of the foreign plant quarantines.

In connection with the enforcement of Quarantine No. 58, inspections are made in the orchards and fields, in packing houses, and on the docks, of such fruits and vegetables as are permitted to move to the mainland. During the year 2,221 shipments consisting of 590 bunches of bananas, 432,992 crates of pineapples, and 14,426,534 pounds of other approved fruits and vegetables were certified for such movement. Through cooperation with post-office officials, parcel-post packages destined for points on the mainland are inspected at the four main post offices on the island. This arrangement makes it possible to intercept much prohibited plant material before it leaves the island and reduces considerably the number of Puerto Rican mail packages requiring inspection upon arrival at New York. A total of 2,983 parcel-post packages were examined and 200 were found to contain prohibited plant material and were returned to the sender.

In Hawaii the enforcement of foreign plant quarantines is handled wholly by insular inspectors serving as collaborators. The inspectors of this Bureau stationed in the Hawaiian Islands are engaged in the enforcement of Quarantine No. 13, which governs the movement of fresh fruits and vegetables to the mainland. During the year 1,918 shipments consisting of 104,855 bunches of bananas, 39,079 crates of pineapples, 41,470 coconuts, and 5,211,484 pounds of other approved fruits and vegetables were inspected and certified. These inspections took place in the fields, in packing houses, and on the docks.

Considerable time was devoted to the inspection of parcel-post packages destined for points on the mainland and 107,820 such packages were opened and inspected while the plant-quarantine status of 212,211 additional packages was determined by other means. One hundred and thirty-one packages were found to contain prohibited plant material.

Other activities in Hawaii consisted of the inspection and sealing of 3,329 pieces of baggage leaving Hawaii by boat, 1,367 pieces of baggage leaving by airplane, 3,048 air-express packages, 392 express packages leaving by boat, and 49 airplanes, all destined for points on the mainland.

INSPECTION OF SPECIAL-PERMIT AND DEPARTMENTAL PLANT MATERIAL

Importations of propagating plant material are inspected at special ports of entry designated for that purpose. Most of the special-permit importations, however, are inspected and treated at the inspection house in Washington, D. C.

Departmental importations and plant-propagating material distributed by the Department are also inspected at the inspection house, and shipments of domestic plants entering and leaving the District of Columbia are also examined for injurious pests. A summary of the inspections and treatments of nursery stock at the inspection house appears in table 19.

TABLE 19.—*Summary of plants and plant products offered for inspection in the District of Columbia, fiscal year 1938*

Material inspected	Foreign	Domestic	Fumigated	Otherwise treated	Infested with insects	Infected with diseases
Lots of seeds (departmental)	5,283	12,300	11,001	764	73	62
Plants, cuttings, bulbs, roots, rhizomes, etc. (departmental)	9,424	232,396	5,979	11,364	[1] 584	[1] 1,215
Miscellaneous unclassified material, other than plants and seeds (departmental)	87	57	70	2	2	1
Shipments of plants under regulation 14, Quarantine No. 37 (commercial)	3,361	0	360	99	489	750
Shipments of plants and plant products under regulations 3 and 15, Quarantine No. 37 (commercial)	1,349	----------	246	194	157	25
Containers of domestic plants other than departmental (mail, express, freight, and truck)	----------	13,019	----------	4	51	2
Shipments of plants by private individuals	----------	3,227	9	25	47	35
Interceptions of plants and plant products at Washington	1,697	----------	16	36	18	1
Interceptions of plants and plant products referred to Washington	1,403	----------	160	652	117	20
Parcels of cotton samples referred to Washington	13,178	----------	13,178	----------	----------	----------

[1] Lots.

INSPECTION OF PLANT-INTRODUCTION AND PROPAGATING GARDENS

Plant material which is being propagated at plant-introduction gardens maintained by the Bureau of Plant Industry is inspected at regular intervals for the presence of plant pests. Plant material distributed from the plant-introduction garden at Coconut Grove, Fla., was inspected by State officials cooperating with this Bureau. The inspections at the plant-introduction garden at Chico, Calif., were handled jointly by an inspector of this Bureau and an entomologist from the California State Department of Agriculture. Material distributed from the District of Columbia, Maryland, and Savannah, Ga., was inspected by inspectors of the Bureau. A summary of these inspections appears in table 20.

TABLE 20.—*Plants, budsticks, cuttings, tubers, roots, and shipments of seeds examined for distribution from plant-introduction and propagating gardens, fiscal year 1938*

Station	Plants	Budsticks, cuttings, tubers, and roots	Shipments of seeds	Station	Plants	Budsticks, cuttings, tubers and roots	Shipments of seeds
Bell, Md.	56,821	741	14	District of Columbia	10,645	6,538	10,401
Chico, Calif.	9,330	775	94	Mandan, N. Dak.	591,807	----------	----------
Coconut Grove, Fla.	4,284	355	41				
Savannah, Ga.	1,262	309	2	Total	674,149	8,718	10,552

INTERCEPTIONS OF PROHIBITED AND RESTRICTED PLANTS AND PLANT PRODUCTS

The inspection of ships, airplanes, vehicles, cargo, baggage, ship's stores and quarters, and foreign mail packages at the maritime and Mexican and Canadian border ports resulted in the interception of large quantities of prohibited and restricted plant material. Many of these interceptions were found to be infested with insects or infected with plant diseases; many others, while showing no infestation or infection, must be considered potentially dangerous since they are known hosts of pests in the country of origin. In classifying the interceptions, those made at bridges and crossings at the Mexican and Canadian border ports have all been considered as having been taken from baggage. A record of the number of interceptions of prohibited and restricted plant material appears in table 21.

TABLE 21.—*Number of interceptions of prohibited and restricted plants and plant products, fiscal year 1938*

Port	In baggage		In cargo		In mail		In quarters		In stores		Total	
	Prohibited	Restricted	Prohibited	Restricted	Prohibited	Restricted	Prohibited	Restricted	Prohibited	Restricted	Prohibited	Restricted
Baltimore	8	13	48	0	29	3	71	10	165	1	321	27
Bellingham	------	------	------	------	------	------	1	1	2	1	3	2
Blaine	1,341	783	------	------	------	------	------	------	------	------	1,341	783
Boston	107	161	13	7	74	63	7	9	20	1	221	241
Brownsville	6,176	688	------	------	1	0	------	------	------	------	6,177	688
Buffalo [1]	3	949	1	1	14	7	------	------	------	------	18	957
Calexico	2,834	62	------	------	------	------	------	------	------	------	2,834	62
Charleston	17	0	3	0	------	------	30	2	16	0	66	2
Chicago	------	------	16	16	188	58	0	1	------	------	204	75
Del Rio	513	132	------	------	------	------	------	------	------	------	513	132
Detroit	35	408	4	3	66	48	------	------	------	------	105	459
Douglas	430	55	------	------	------	------	------	------	------	------	430	55
Eagle Pass	1,288	214	------	------	------	------	------	------	------	------	1,288	214
El Paso	6,905	1,142	------	------	24	14	------	------	------	------	6,929	1,156
Galveston	1	2	------	------	------	------	441	7	97	1	539	10
Guam	1	0	4	0	------	------	------	------	26	0	31	0
Gulfport [2]	------	------	0	1	------	------	11	0	6	0	17	1
Hidalgo	2,749	419	------	------	------	------	------	------	------	------	2,749	419
Honolulu [3]	784	273	96	419	142	118	------	------	40	4	1,062	814
Houston	11	0	7	0	3	0	417	0	62	0	500	0
Jacksonville [3]	0	1	------	------	4	1	17	6	18	2	39	10
Key West [3]	60	136	0	1	------	------	20	94	1	1	81	232
Laredo	14,888	1,346	------	------	36	10	------	------	------	------	14,924	1,356
Los Angeles [3]	1	0	------	------	46	18	------	------	------	------	47	18
Mercedes	303	31	------	------	------	------	------	------	------	------	303	31
Miami [3]	1,907	778	37	9	14	9	787	386	103	7	2,848	1,189
Mobile	9	4	0	5	------	------	178	0	69	2	256	11
Naco	151	37	------	------	------	------	------	------	------	------	151	37
New Orleans	320	135	11	7	12	5	906	107	171	5	1,420	259
Newport News	------	------	1	1	------	------	38	2	17	0	56	3
New York	2,701	1,598	541	88	472	183	151	30	84	3	3,949	1,902
Nogales	3,461	726	------	------	3	7	------	------	------	------	3,464	733
Norfolk	12	2	1	0	------	------	137	8	32	1	182	11
Pensacola [3]	------	------	------	------	------	------	12	0	9	0	21	0
Philadelphia	25	13	11	1	125	15	89	23	115	10	365	62
Port Arthur	17	3	------	------	------	------	1,028	0	195	0	1,240	3
Port Huron [3]	2	128	------	------	------	------	------	------	------	------	2	128
Portland	------	------	10	3	15	8	3	1	16	2	44	14
Port San Luis [3]	------	------	------	------	------	------	3	0	------	------	3	0
Presidio	186	39	------	------	------	------	------	------	------	------	186	39
Puerto Rico (all ports)	60	85	1	0	------	------	2	1	1	1	64	87
Roma	151	28	------	------	------	------	------	------	------	------	151	28
St. Paul	------	------	------	------	36	23	------	------	------	------	36	23
San Diego [3]	8	5	2	3	3	0	29	9	67	10	109	27
San Francisco [3]	185	12	6	1	50	41	161	0	118	3	520	57
San Pedro [3]	355	33	13	1	------	------	94	6	166	6	628	46
San Ysidro	6,420	510	------	------	------	------	------	------	------	------	6,420	510
Savannah	------	------	------	------	------	------	118	0	13	0	131	0
Seattle	249	36	26	0	22	9	12	0	20	1	329	46
Tampa	4	6	------	------	0	3	13	0	29	0	46	9
Ventura [3]	------	------	------	------	------	------	------	------	1	0	1	0
West Palm Beach [3]	0	1	------	------	------	------	1	7	------	------	1	8
Total	54,678	10,994	852	567	1,379	643	4,777	710	1,679	62	63,365	12,976

[1] Includes interceptions made at Niagara Falls.
[2] Work handled by inspectors stationed at Mobile.
[3] Collaborators stationed at these ports

PESTS INTERCEPTED

The inspectors and collaborators of the Bureau collected from foreign plants and plant products insects belonging to 1,062 recognized species and others distributed among 930 genera and families, fungi and bacteria belonging to 304 recognized species, plant-parasitic nematodes belonging to 11 recognized species, and numbers of interceptions of diseases caused by fungi, bacteria, viruses, or other agents that could be referred to family, genus, or other group only. Many of these interceptions were of economic importance or of scientific interest, or both.

A total of 49,930 interceptions of insects and plant diseases were made during the year. A summary of the interceptions appears in table 22.

TABLE 22.—*Number of interceptions of insects and plant diseases made during the fiscal year 1938*

Port	Cargo		Stores		Baggage		Quarters		Mail		Total	
	Insects	Diseases	Insects	Diseases	Insects	Diseases	Insects	Diseases	Insects	Diseases	Insects	Diseases
Baltimore	53	15	55	56	3	6	9	5	25	5	145	87
Bellingham	8	1	0	1	0	0	0	0	0	0	8	2
Blaine	1	0	0	0	14	12	0	0	0	0	15	12
Boston	99	121	157	313	67	28	7	8	91	44	421	514
Brownsville	2,045	93	28	19	7,520	474	26	0	1	0	9,620	586
Buffalo	36	30	0	4	3	1	0	0	18	8	57	43
Calexico	2	0	0	0	43	0	0	0	0	0	45	0
Charleston	13	2	8	21	3	1	1	2	0	0	25	26
Chicago	50	3	3	1	0	0	0	0	24	1	77	5
Del Rio	0	0	0	0	15	0	0	0	0	0	15	0
Detroit	22	33	0	0	2	0	0	0	21	10	45	43
Douglas	0	0	0	0	23	2	0	0	0	0	23	2
Eagle Pass	92	20	0	0	112	9	0	0	0	0	204	29
El Paso	125	19	0	0	147	83	0	0	6	3	278	105
Galveston	83	14	25	472	1	0	5	3	0	0	114	489
Guam	0	0	3	0	0	0	343	0	0	0	346	0
Hidalgo	80	13	0	0	510	2,375	0	0	0	0	590	2,388
Honolulu	433	5	3	0	213	0	350	0	318	0	1,317	5
Houston	11	4	25	576	1	0	0	1	1	0	38	581
Jacksonville [1]	12	0	30	74	0	0	7	1	3	1	52	76
Key West [1]	0	0	0	0	25	3	1	1	0	0	26	4
Laredo	2,488	5	0	0	561	14	0	0	4	0	3,053	19
Los Angeles [1]	1	0	0	0	0	0	0	0	9	0	10	0
Mercedes	0	0	0	0	278	3	0	0	0	0	278	3
Miami [1 3]	100	8	39	17	476	16	155	3	4	0	774	44
Mobile [2]	61	4	27	241	0	1	7	2	0	0	95	248
Naco	0	0	0	0	28	1	0	0	0	0	28	1
New Orleans	560	32	135	93	66	8	52	9	2	1	815	143
Newport News	4	0	13	39	0	0	0	1	0	0	17	40
New York	2,029	3,029	324	341	635	337	63	42	685	118	3,736	3,867
Nogales	2,724	656	0	0	1,440	150	0	0	4	0	4,168	806
Norfolk	102	32	29	192	0	1	0	3	0	0	131	228
Pensacola [1]	0	0	5	3	0	0	5	0	0	0	10	3
Philadelphia	74	256	151	900	11	21	27	58	83	79	346	1,314
Port Arthur	0	0	86	363	0	0	9	5	0	0	95	368
Portland	3	1	2	2	0	0	0	0	4	1	9	4
Presidio	3	0	0	0	32	0	0	0	0	0	35	0
Roma	1	0	1	0	37	43	0	0	0	0	39	43
St. Paul	0	0	0	0	0	0	0	0	14	12	14	12
San Diego [1]	10	0	49	5	4	0	13	2	5	0	81	7
San Francisco [1]	2,592	409	113	14	737	37	140	2	840	149	4,422	611
San Juan	34	24	2	1	48	3	0	0	1	0	85	28
San Pedro [1]	247	0	221	47	153	8	8	1	0	0	629	56
San Ysidro	3	1	0	0	156	7	0	0	0	0	159	8
Savannah	5	0	7	41	0	0	0	0	0	0	12	41
Seattle	245	91	62	36	49	21	35	6	49	6	440	160
Tampa [1]	9	2	8	24	2	2	0	0	0	0	19	28
Washington, D. C	1,111	1,244	0	0	56	9	0	0	1,137	333	2,304	1,586
Total	15,571	6,167	1,611	3,896	13,471	3,676	1,263	155	3,349	771	35,265	14,665

[1] Collaborators stationed at these ports.
[2] Includes interceptions at Gulfport, Miss.
[3] Includes 63 airplane interceptions made by Public Health Service.

NOTE.—Inspectors stationed at Puerto Rico made 4 interceptions of insects during their field and packing-house inspection of fruits and vegetables for shipment to the mainland.

CERTIFICATION FOR EXPORT

During the year 9,208 certifications covering 4,017,807 containers of plants and plant products were made to meet the sanitary requirements of foreign countries. This represents an increase of 1,799 (24 percent) in the number of certifications and of 1,237,238 (44 percent) in the number of containers certified as compared with 1937.

Export certificates were issued at 33 ports covering 67 different commodities which were exported to 72 foreign countries. Some of the more important commodities certified were: Apples, 3,093 shipments, consisting of 1,906,522 boxes, 60,140 baskets, and 36,947 barrels; pears, 1,012 shipments, consisting of 621,607 boxes; oranges, 584 shipments, consisting of 271,440 boxes; potatoes, 1,328 shipments, consisting of 618,676 bags, 47,637 crates, 19,847 barrels, and 20 boxes.

Many of the shipments of apples and pears were certified under the cooperative arrangement with the Bureau of Agricultural Economics of the Department, whereby licensed inspectors of that Bureau located at shipping points make inspections and issue reports which are accepted by the plant quarantine inspectors at the ports of export as a basis for issuing the required export certificate.

A summary of the export certification work appears in table 23.

TABLE 23.—*Certification for exportation, by ports, fiscal year 1938*

Ports	Certificates issued	Total containers certified	Commodities certified	Foreign countries	Ports	Certificates issued	Total containers certified	Commodities certified	Foreign countries
	Number	*Number*	*Number*	*Number*		*Number*	*Numer*	*Number*	*Number*
Baltimore	120	43,559	2	2	New Orleans	20	2,613	8	8
Boston	2	2	1	2	Newport News	35	742	1	1
Brownsville	4	367	2	2	New York	4,830	1,418,013	35	56
Buffalo	1	40	1	1	Nogales	44	158	5	1
Calexico	85	40,569	7	2	Norfolk	2	27	1	1
Canal Zone	11	13	1	7	Philadelphia	7	18	2	3
Chicago	6	118	3	6	Port Arthur	9	46,443	2	2
Detroit	94	2,689	4	6	Portland	821	504,631	7	13
Douglas	1	20	1	1	San Francisco	408	199,452	16	10
Eagle Pass	1	19	1	1	San Juan	12	13	2	9
El Paso	108	4,312	10	1	San Pedro	462	219,326	5	7
Galveston	9	95	3	4	Savannah	1	29	1	1
Hidalgo	37	1,226	10	1	Seattle	1,974	1,481,265	15	15
Houston	9	44,665	4	3	Tampa	1	1	1	1
Jacksonville	5	3,012	2	4	Washington, D. C.	12	24	2	5
Laredo	10	483	4	1					
Los Angeles	57	3,848	5	5	Total	9,208	4,017,807	------	------
Mayaguez	10	15	2	5					

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